

**NAVAL SIMULATIONS  
(NAVSIM) 1939-45**

**RULE SET**



**THE WAR AT SEA 1939-1945**

**April 2024**

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## **BACKGROUND**

The Naval Simulations (NAVSIM) Rules Set 2 is intended to simulate naval operations and tactical combat during the War at Sea 1939-1945. Scale ship models or counters are used to represent actual ships in order to simulate all aspects of naval warfare during this period. Due to the complexity of naval warfare the rules are split into sections covering naval campaigns and operations, as well as naval tactical surface, air, underwater, amphibious, and small boat actions. Naval simulations, also known as naval wargaming, allows one to practice aspects of warfare in times of peace.

### **Aims of Naval Simulations**

The main aim of naval simulations is to enjoy the experience. However it is also a good means to generate interest, knowledge and experience in naval command, leadership and decision making. It may also generate discussions on past, current and future naval events. Naval wargaming generates decision making experience as well as decision making information. That said it is just a game!

### **Requirements**

To play you need – representative scale ship models or cards, tape measure (3m is OK), a six sided dice (D6), a ten sided percentile dice (D10), pen, paper, a brain, and a flat playing surface, or ‘table’ – actually a large table or clear floor area is good. It is also easier to print out copies of relevant ship characteristics and related information, cut and paste from these rules, for a particular game scenario.

### **Scales**

One ship model represents one ship in real life. One aircraft model represents one aircraft in real life. Ship models are 1:1200 to 1:3000 scale.

Campaign maps (typically with squares or hexes representing 15 nautical miles across) and hourly moves are used to simulate naval campaigns and operations. A Task Force travelling at 30 knots (nautical miles per hour) moves 2 squares or hexes on the map per hourly move. An Air Group cruising at 120 knots moves 8 hexes on the map per hourly move.

For tactical combat. one game turn represents 3 minutes. Table scale is one metre represents 20,000 yards. So 20cm on the table represents 1 nautical mile (2000yds), 480cm is 24nm (48,000yds), 100cm is 5nm (10,000yds), 8cm is 800yds, and 1cm on the table represents 100yds in real life.

Ship and aircraft movements are in knots (nautical miles per hour). On the table using the above scales a ship moves 1cm for each knot of speed each game turn. So

a 32kn ship moves 32cm per turn. Aircraft travelling at 210 nautical miles per hour move 210cm per turn. Easy to remember.

## Naval Campaigns

These NAVSIM 1939-45 rules are designed to cover both operational level command and tactical level combat. The relevant rules are set out in following sections. The board game *Flat Top* (Avalon Hill, 1977) has been generally expanded to form the basis of these NAVSIM campaign rules. The *Flat Top* board game may be used, as the basis for campaigns fought in the South-West Pacific Area during 1942 and early 1943, however in order to simulate naval campaigns in other theatres – say Norway 1940, Atlantic 1941, and Mediterranean 1940-1941 - these NAVSIM rules will apply. Useful campaign or operational level maps may be generated or simply copied from the Official Histories for the other theatres. In NAVSIM rules, 1 hex or square on the campaign map represents 20 miles (30,000 yds or 15nm). Ships at 30kn move 2 hexes per hour. Also note that in these NAVSIM rules aircraft are represented in 1:1 scale, while *Flat Top* uses air factors representing three aircraft. In a campaign it is always an option to conduct tactical combat using the *Flat Top* rules which are at the operational level – ie. simpler and quicker but with less tactical detail and less overall accuracy. Similar board games can also be used to provide suitable maps for naval campaigns, For instance the *Supermarina* (1984) board game has several useful maps that are suitable for Mediterranean naval campaigns. Alternatively it is possible to avoid using hexes or squares entirely. Original naval campaigns were fought using standard maps with actual Task Force and Air Group movements plotted on them.

## Ship Characteristics

Each ship model represents an actual ship. Task Forces (TF), squadrons and fleets represent actual commands. Formations, tactics and doctrine reflect those used at the time of simulated combat. For the purposes of these rules each ship has defined characteristics, based on the actual ships. In summary these are:

- **Name and year of commissioning:** eg. HMAS *Canberra* (1928)

- **Damage Points:** A measure of the combat strength of the vessel – based upon standard tonnage, overall length and breadth, armour and survivability of the ship. Note 'warships' are generally designed to naval standards 'to float, to move, and to fight' while 'merchant' vessels are not. For example aircraft carriers, auxiliaries, and merchant vessels are less survivable although their size often increases their overall damage points.

- **STF (Ship Target Factor):** The physical size modified by the vessels manoeuvrability gives a STF. The first number is for full length targets while the second number (x.66) is for bow/stern (end-on) target. Smaller warships will present a reduced target than larger battleships or carriers of equivalent lengths. *Canberra*, STF 28/18.

- **TR (Torpedo Rating):** The ability of a ship to sustain torpedo damage. Many small vessels have no protection and will sink if hit by torpedo. Older battleships have considerable protection but are less able to withstand modern torpedoes, etc.

- **Speed:** The maximum distance a ship can move in knots. Ship movements on the table represent actual ship moves. 31kn equals a 31cm move.

- **Armour:** The metal protection provided to parts of a warship. Every inch of armour (sometimes modified for angle, form and strength) is measured against the penetration capable by the opponent's gunfire, depending on firing size, type, and range. The armour is given in 5 categories. A1 is for the belt. A2 for the deck. A3 for the main turrets. A4 for the secondary guns and A5 for the vitals (including conning tower). Armour and penetration values are in inches rounded up. No armour is written as a dash '-'. Eg. *Canberra*, Armour 1/3/2/2/3.

- **Armament:** The calibre (in inches) and type of guns onboard the ship. Actual gun turrets and/or positions are represented on the model/card. Every ship's gun, 3-inch or more, has its own gun characteristics – see paragraph below for details. Smaller guns, under 3-inch, are typically used for anti-aircraft (AA) fire or against patrol craft or targets ashore. Small gunfire is incorporated, with larger AA and DP (Dual Purpose) gunnery, in the AAF (Anti-Aircraft Fire Factor). The AAF will be explained later when we deal with tactical combat AA Fire.

- **Other Characteristics:** These include the number and type of torpedoes carried. Aircraft carried, launching and recovery facilities. Radars installed – surface search, air search, gunnery, etc. Mines, Sonar/ASDIC and depth charge arrangements.

A listing of ship characteristics is included in the data set associated with this rule set. Every warship is different. Some ships' capabilities vary considerably over time while many ships within one class of ships will also vary in detail ship to ship. While all effort has been made to generate an accurate list of ship characteristics, original sources vary (especially internet ones) and some judgement was required. If you disagree – do the research and amend the ship characteristics you use. Beware however that this is still just a simulation. From experience detailed arguments may lead to unpleasantness! Roll the percentile dice to resolve disputes and maintain good game-play as necessary. Always round down when calculating percentages.

### Aircraft Characteristics

Each air model represents a single actual aircraft of the same type/name. At times it is possible to use a scale of 1 to 3 for large air attacks. Air flights, squadrons and groups represent actual commands. For the purposes of these rules each aircraft type/name has defined characteristics, representing the actual aircraft, seaplanes and flying boats. In summary these are: aircraft name/type, designation (ie. SW for Swordfish), air attack factor (AF), air defence factor (DF), maximum speed (knots), range, endurance, altitude (feet) and armament. The air characteristics also include air attack capabilities vs ships and land bases including level bombing (high or low altitude), dive bombing, depth charging, and torpedo bombing. Note they are based on actual aircraft figures, using *Flat Top* air rules & *SeeKrieg 4* (1981) rules as guides.

The air operations section of these rules covers the allocation, readying, launching and movement of Air Groups on the campaign map using hourly moves. Tactical combat sections of these rules are separate, with the intention that they serve only naval aspects of the game. The naval air combat tactical rules simulate Air-to-Air combat, Ship Anti-Aircraft Fire, and Air Attacks on Ships.

## Naval Weapon Characteristics

Each gun on the ship model, or listed on the related ship characteristic, represents an actual naval gun. Gun characteristics are listed for each nation in a separate listing to this rule set. The naval gun characteristics include: size, calibre and mark/type of gun. A gun factor (probability of a 'standard' hit), maximum range (yards), and the equivalent damage points caused by a hit – either after penetration and internal detonation (ID) or without penetration as external detonation (ED). Gun characteristics include maximum armour penetration at long, middle and close ranges, and the actual ships and/or classes equipped with the gun.

Ranges are defined as – Long Range from 51% to 100% max range ( $>\frac{1}{2}$  max),

Medium Range 2000yds to 50% max range ( $<\frac{1}{2}$  max),

Close Range ( $< 2000$ yds or 1nm).

Background data on a typical variety of naval torpedoes, mines, depth charges, radars, sonars and other specialist weapons and sensors is also provided in the accompanying data listings.

## Background Sources

These rules have been developed using many sources. The rules have evolved from the Mal Wright's *WWII Naval Rules* (Adelaide, 1978), *Flat Top* (1977), *Skytrex* (1981), & *SeeKrieg4* (1981). Ultimately they have evolved from Fred T. Jane's *Naval Wargame Rules* (1906) & (1912), and Fletcher Pratt's *Naval War Games* (1940), with reference to Donald Featherstone's *Naval War Games* (1975). Important references include: John Campbell's, *Naval Weapons of World War II* (1985), Erminio Bagnasco, *Submarines of World War II* (1977), Friedman's, *Naval Radar* (1981), as well as the many books by Norman Friedman. It seems that data on WWII naval ships, aircraft & weapons is now readily available online for those who can look below the surface slurry. Note that these rules are intentionally a reversion to pre-computerised naval simulations where realistic details can generate a greater empathetic understanding for the conditions of actual naval warfare.

Note although these NAVSIM Rules and associated Data Sets are comprehensive, it is not possible to simulate every aspect of naval warfare 1939-45 in detail. Anyone wishing to go deeper down the rabbit hole is welcome to modify or adapt these rules to better reflect their own needs. Reference to the latest source materials should help you here.

The NAVSIM 1939-45 Rules Set were developed with good intentions, as a non-profit, free-use endeavour. Please use them accordingly. Good luck and enjoy!

G.P. Gilbert, Canberra, April 2024

## CAMPAIGN TURNS

Before naval tactical combat can commence certain preliminary actions have to be resolved. They include: weather and sea conditions, air operations, air searches, map movement (for ships and aircraft), and sightings (air, surface and radar). When fighting a campaign many of these preliminaries will be established already.

### Map Movement

All ships and aircraft are moved on the campaign map until they are sighted, at which point naval tactical combat commences. In practice a naval campaign may consist of a number of naval operations which include numerous naval tactical combats. For historical simulations naval tactical combat occurs in identical circumstances to those documented historically. Each campaign map movement turn is for 1 hour. At times to speed up a campaign, when tactical action is unlikely, 6 hourly campaign moves may be useful - perhaps two daytime and two night 6 hour moves.

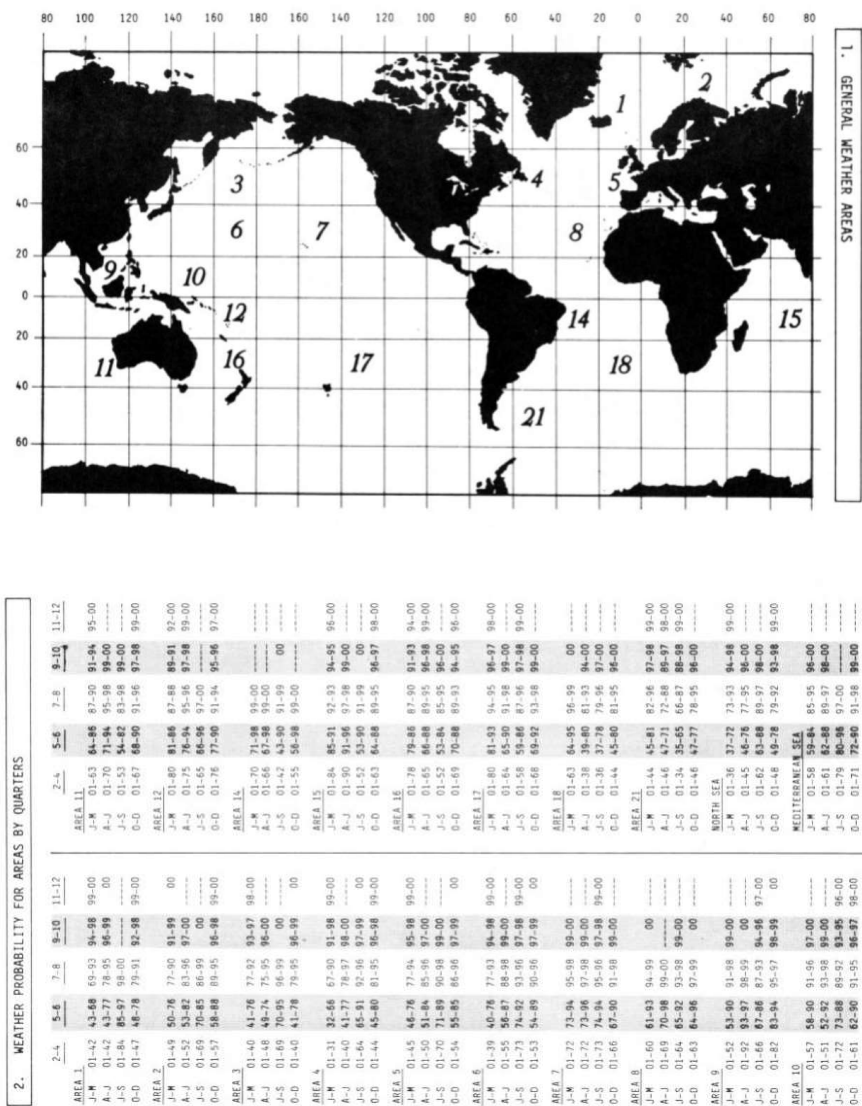
### Weather and Sea Conditions

Weather and sea conditions such as clouds, storms, wind strength and direction, clearness/lightness/darkness, and sea state (Beaufort Number) all affect naval combat in some way. For historical simulations the weather and sea conditions at the time of action are used. For campaigns use the *Flat Top* rules or similar for weather and sea conditions. To generate variable weather and sea conditions use the Weather Tables below, as sourced from *SeeKrieg 4* (1981) rules.

BEAUFORT NUMBER	WIND SPEED	DESCRIPTION	REDUCE VISIBILITY	EFFECT ON SHIPBOARD OPERATIONS	
0	0-1 knots	CALM - Sea like a mirror.	--	NONE	
1	2-3 knots	LIGHT AIR - Ripples form.	--	NONE	
2	4-6 knots	LIGHT BREEZE - Small wavelets form.	--	NONE	
3	7-10 knots	GENTLE BREEZE - Large wavelets with some breaking crests.	--	NONE	
4	11-16 knots	MODERATE BREEZE - Small waves with breaking crests.	--	NONE	
5	17-21 knots	FRESH BREEZE - Moderate waves with many breaking crests and some spray.	--	NONE	
6	22-27 knots	STRONG BREEZE - Large waves with extensive whitecaps and spray.	--	0-30 DP SHIPS	10%
7	28-33 knots	MODERATE GALE - Sea heaps up and white foam from breaking waves begins to be blown along the direction of the wind.	5%	0-40 DP SHIPS 41-90 DP SHIPS	20% 10%
8	34-40 knots	FRESH GALE - Moderately high waves of greater length; edges of crests break into spindrift. Foam is blown in well-marked streaks.	10%	0-40 DP SHIPS 41-120 DP SHIPS	30% 15%
9	41-47 knots	STRONG GALE - High waves. Dense streaks of foam. Sea begins to roll. Much spray.	20%	0-30 DP SHIPS 31-100 DP SHIPS 101-200 DP SHIPS	40% 30% 15%
10	48-55 knots	WHOLE GALE - Very high waves with long overhanging crests. White appearance of sea. Rolling of sea becomes heavy.	40%	0-40 DP SHIPS 41-150 DP SHIPS 151-500 DP SHIPS 501+ DP SHIPS	50% 40% 20% 10%
11	56-66 knots	STORM - Exceptionally high waves. Entire sea is white with foam and spray.	60%	0-100 DP SHIPS 101-500 DP SHIPS 501+ DP SHIPS	50% 40% 25%
12	66+ knots	CYCLONE - The air is filled with foam and spray. Extremely high seas. Ships under 100 DP in danger of being lost or severely damaged.	80%	0-200 DP SHIPS 201-500 DP SHIPS 501+ DP SHIPS	80% 50% 40%

#### BEAUFORT SEA STATE TABLE:

For effect on visibility and ship board operations see under para. 'Detection'.  
DP x 50 equals ship 'damage pts' in these rules. The % reduction applies to both max speed and gunfire hits.



Note that most ships and all aircraft cease operations during Storms and/or Gales (Beaufort Scale 9-12). Ships and aircraft have to leave the Storm/Gale area – 15nm (or 1 hex) – by the shortest route possible. Tactical combat does not occur during Storms/Gales.

## CAMPAIGN AIR OPERATIONS

Naval air operations were a fundamentally important component of WWII naval campaigns. In these rules a modified *Flat Top* version of air operations is used to simulate actual decisions to ready, launch, move, and recover aircraft. Sea-based and land-based air operations are conducted only during naval campaign moves where each campaign move lasts 1 hour. Tactical combat between aircraft and air attacks against ships, submarines and other vessels are covered within these rules by the later section on Naval Tactical Surface Combat, which uses 3 minute turns.

Naval Aircraft Carriers include all vessels capable of launching aircraft. This includes Fleet Carriers (CV), Light Carriers (CVL), Escort Carriers (CVE), Seaplane Carriers (AV & CAV), as well as those warships that can operate their own aircraft, typically some Battleships (BB), Heavy Cruisers (CA), & Light Cruisers (CL).

Aircraft Definitions: Armed Aircraft, also called Bombers, are those aircraft carrying bombs, torpedoes or depth charges that are capable of conducting air attacks against ships. Unarmed Aircraft, also called Interceptors, are those armed with air-to-air weapons only, including fighters, unarmed bombers, and reconnaissance aircraft.

### Carrier and Air Base Operations

Information on each ship and air base capable of conducting air operations is available in the scenario explanation or within the accompanying data sheets. Aircraft ordered to conduct a specific air mission are formed into Air Groups (AG) which are readied, launched, moved, and recovered as a single formation. Individual air groups may consist of any number and type of aircraft desired although their movement and range characteristics would be limited by the minimums of the aircraft types in the formation.

### Maximum Capacity, and Launch Factors

The number of aircraft placed on any carrier, ship or base cannot exceed the Maximum Capacity (MC) for that carrier. Note some air bases have an unlimited MC ( $MC=\infty$ ). Aircraft may begin the naval campaign or scenario in any state of readiness. The Launch Factor (LF) is the number of aircraft that may take off or land from a carrier, ship or base in any one hour move. Only fully 'Ready' aircraft may be 'Launched'. The Normal LF is given on the left of the slash mark (/), while the Minimum LF is given to the right of the slash mark (/). The Maximum LF is twice the Normal LF. Aircraft launched using the Minimum LF may move up to their full Movement Factor (MF). Aircraft launched using the Normal LF may move up to 1/2 MF. Aircraft launched using the Maximum LF must remain above the TF or base for their full hourly move. By combining LFs it is possible to launch three separate Air Groups/hour, as long as the Maximum LF is not exceeded.

For example CV USS *Yorktown* has a Maximum Capacity (MC) of 90 meaning it can carry up to 90 aircraft. Launch Factor (LF) of 33/9 meaning that it has a Minimum LF of 9 aircraft, a Normal LF of 33 aircraft, and a Maximum LF of 66 aircraft. If the aircraft are ready, the *Yorktown* could launch three Air Groups - say AG3 of 9 Devastators and move them a full MF, then AG4 of 24 Wildcats and move them 1/2 their MF, and still launch AG5 of 33 Dauntless aircraft that remain above the carrier.

## Air Record Sheet

An Air Record Sheet is used to record the flight details of each Air Group assembled during the Air Operations Phase of the hourly move. Once logged on the Air Record Sheet the aircraft must take off during the Plane Movement Phase of the hourly move. All Air Groups are given an AG number and the aircraft models/counters assembled to reflect the actual aircraft.

The carrier/base is recorded along with a cross representing the time at take off. Using the Aircraft Data tables for each specific aircraft the Range Factor (RF) is determined and the aircraft designation marked on the Air Record Sheet at the hour that the aircraft must land. When two or more aircraft RFs are associated with the Air Group both RFs are recorded on the Air Record Chart.

In the Aircraft Data Chart example opposite, AG18 consisting of P-40 and Beaufort aircraft takes off from Port Moresby at 0800. The P-40s have a RF of 4 hence their landing time is set at 1200. The Beaufighters have a RF of 5 hence their landing time is set at 1300.

A blank Air Record Chart is provided for use.

## Carrier Readyng Factors

Each carrier/base has a Readyng Factor (RDF) which represents the maximum number of aircraft that may move between the 'staging boxes' on that carrier/base. A move may be from the Just Landed box to the Readyng box. From the Readyng box to the Ready box, or returning from the Ready box to the Readyng box. All three box moves may be combined up to the limit of the RDF. No aircraft may make more than one RDF move between boxes per 1 hour move.

## Arming Aircraft

Aircraft arming occurs when moving between the Readyng box to the Ready box. Each aircraft is armed with either General Purpose (GP) bombs, Armour Piercing (AP) bombs, Depth Charges (DC), or Torpedoes (TT). Only those weapons capable of being carried by the aircraft concerned and actually trained to be used by their crews at the time of the campaign may be used when arming aircraft. Aircraft may proceed from the Readyng box to the Ready box unarmed, typically fighters and

	16	17	18	19	20
TIME			PM		
0100					
0200					
0300					
0400					
0500					
0600					
0700					
0800			X		
0900					
1000					
1100					
1200			40		
1300			BF		
1400					
1500					
1600					
1700					
1800					
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reconnaissance aircraft. Any aircraft which needs to be rearmed, say from GP bombs designed for land targets to AP bombs designed for warship targets, will need to use the RDF to move back to the Ready box and the following hour proceed from the Ready box to the Ready box. Only aircraft in the Ready box may be launched.

### Plane Handling

An aircraft can only take-off or land on a carrier, ship or air base that is capable of handling that type of aircraft. CVs, CVLs, and CVEs may only carry carrier type aircraft. AVs, CAVs, and some BBs, CAs & CLs may carry specific types of float planes (FP). Larger sea planes (SP) mostly operate from a seaplane base established ashore. Land based (LB) aircraft typically operate from an air base.

### Dispersal

Aircraft operating from air bases may be dispersed to minimise aircraft losses. Aircraft in the Ready box may be moved to the Dispersed box using one RDF for every aircraft dispersed. Dispersed aircraft then can move to the Ready box using another RDF.

### Sequence of Campaign Air Operations

1. Move aircraft from Ready boxes to Ready boxes. Arming them when desired. Undispersed aircraft to Ready boxes.
2. Form Air Groups using aircraft available in Ready boxes, including those moved from Ready boxes this turn.
3. Move aircraft from Just Landed boxes to Ready boxes.
4. Move aircraft from Ready boxes to Ready boxes. Disperse aircraft.

Each air operations move lasts for 1 hour. Map movement is used to determine all sea and air campaign moves, and if and when TFs or AGs meet, observation results, and/or tactical combat ensues.

### Air Searches

Reconnaissance aircraft are used during campaigns/operations to locate and identify task forces, air groups/formations, land bases, ships and aircraft. Search aircraft may 'observe' Task Forces (TFs) or Air Groups (AGs) up to 30nm of their movement (with 66% chance of observation on a clear day) – roll a D6 and consult the Air Search Chart below. Such aircraft do not normally undertake naval tactical combat unless they are used to attack individual ships.

Air Search Chart	
1-4	observed
5-6	failed

Modifiers:	+1 if clouds
	+1 if night
	No observation in storms

## PRELIMINARIES TO TACTICAL COMBAT

### Observation

It is possible to ‘observe’ ship and air groups (TFs, convoys, squadrons and the like) at distances up to 30nm (60,000yds), however at such extreme ranges only traces of smoke or mast tops would be visible (using powerful binoculars or equivalents). Air groups could be ‘observed’ using radar out to 45nm (90,000yds). It was difficult to identify them as friend of foe, so ‘detection’ was at much shorter ranges. See the Observation Tables below for daytime and nighttime hourly moves:

#### OBSERVATION TABLE: FOR DAYTIME HOURLY MOVES

OBSERVING UNIT	UNIT BEING OBSERVED	WEATHER	DISTANCE – OBSERVER/OBSERVED			
			0-7.5nm	15nm	30nm	45nm
Base/TF/Coastwatcher (Visual)	Air Group	Clear	3	2	1	-
		Clouds	2	1	-	-
	TF/Ships	Clear	3	2	1	-
		Clouds	3	2	1	-
Air Group (Visual)	Air Group	Clear	3	2	1	-
		Clouds	2	1	-	-
	TF/Ships	Clear	3	2	1	-
		Clouds	2	1	-	-
Base/TF with Radar (Radar)	Air Group	Clear	2	2	1	1
		(high altitude only) Clouds	2	2	1	1
	TF/Ships	Clear	-	-	-	-
		Clouds	-	-	-	-

#### OBSERVATION TABLE: FOR NIGHTTIME HOURLY MOVES

OBSERVING UNIT	UNIT BEING OBSERVED	WEATHER	DISTANCE – OBSERVER/OBSERVED			
			0-7.5nm	15nm	30nm	45nm
Base/TF/Coastwatcher (Visual)	Air Group	Clear	1	-	-	-
		Clouds	-	-	-	-
	TF/Ships	Clear	1	-	-	-
		Clouds	1	-	-	-
Air Group (Visual)	Air Group	Clear	2	-	-	-
		Clouds	1	-	-	-
	TF/Ships	Clear	1	-	-	-
		Clouds	-	-	-	-
Base/TF with Radar (Radar)	Air Group	Clear	2	2	1	1
		(high altitude only) Clouds	2	2	1	1
	TF/Ships	Clear	-	-	-	-
		Clouds	-	-	-	-

Distances 0 to 45nm. 15nm = 30,000yds are those from observer to the air or surface ship formation being observed. The observation results are Condition Numbers 1, 2 & 3. These reflect the level of observation possible.

- Condition 1 – the observer is told that something is there – either TF and/or air group without numbers or types.  
 Condition 2 – the observer is told how many air groups and/or TFs are present (+/- 50%), every class of plane (bomber, interceptor) and/or ship present (carriers, capital ships, small ships, auxiliaries & submarines), and the total numbers of ships and aircraft present.  
 Condition 3 – the observer is told the exact number of air groups and TFs present as well as the exact number and type of aircraft (bomber, interceptor) and ships (CV, CVL, BB, CA, CL, DD, PG, AO, AP, & APD & SM) in them. Ship and/or aircraft names are never disclosed until combat occurs.

## Detection

‘Detection’ of ships and aircraft is required before firing can commence. Actual detection (or recognition) occurs when the ship and/or air crew can confirm relevant features and markings as well as the target’s course, range and speed, in order to produce a fire plot. During WWII, detection was conducted in four ways – visually using telescopic ranging, by aircraft spotting, by radar, or by sonar. One ship may be capable of using three or more techniques at the same time, using specialist crew members for each. IFF (Identify Friend and Foe) was used alongside radar for ‘identification’ outside visual range.

The following Detection Table determines the maximum range for target ‘detection’ under various conditions. Visible ranges are reduced according to the size of the target. The maximum practical range for spotting aircraft is limited for communication/coordination reasons to 24nm while each aircraft also needs to fly within the visible range for the conditions to detect a target. For example on a dark night the spotter aircraft has to fly within 4000yds of a battleship target or 800yds of a submarine.

### Ship & Aircraft Detection Table

Condition	Max Range	Modifiers: (Reductions due to Size)
RADAR		No change for BB, CV, AO, large air groups
Max Practical	48,000yds	75% range for CA & CL & small Aux.
AERIAL SPOTTING	48,000yds	50% range for DD, PG, small ships, single a/c
		20% range for SM on surface or awash
		10% range for periscope (3000yds max)
VISIBLE		
Good Visibility	24,000yds	Airborne radar is based on ASV III
Overcast Visibility	20,000yds	50% range for early airborne radar (ASV I/II)
Fog/Moonlight	8000yds	Minimum radar detection range 1,000yds
Dark Night	4000yds	

‘Detection’ is also reduced when the Beaufort Scale is 7 or over (5% to 80%), see Weather Table above.

#### Notes:

- the effectiveness of surface and air search radars is reduced depending on the size of the target. The modifiers reflect this reduced performance.
- aircraft spotting and gunnery radar improved the accuracy of naval gunfire and this is reflected in the Gunnery Fire rules that follow.

## Night

For observation at night refer to the above observation table. Naval tactical combat often occurred at night. Warships were trained to fight in night actions.

Visual detection limits naval tactical combat at night to ranges of 8000yds or less. However there are several ways to improve gunnery at night. Searchlights may be used to illuminate targets at night. A ship using searchlights has to nominate a direction which a beam of light (30 degrees wide) will illuminate targets up to 7000yds (70cm on the table) for as long as they are turned on. The ship using searchlights then is ‘detectable’ to all ships and aircraft within daylight visibility

ranges. Star shells may be fired by ships – using one class of secondary guns (4-inch say) - at an aiming point. They illuminate an area up to 15000yds (150cm) around the aiming point for as many turns as they are fired. Some aircraft can also fire illumination flares but these are too small for gunnery purposes. They do however reveal targets for a single turn. Please note also that any ship that either fires or is on fire at night may be ‘detected’ as in equivalent daylight and this lasts for as long as the ship is firing plus one extra turn (3 mins after firing ceases).

Most aircraft were not able to fight at night. Initially a relatively small number of reconnaissance and bombers aircraft could conduct night operations. Night fighters were sometimes able to engage enemy bombers with the aide of AA fire (firing tracer at high altitude) and searchlights (covering lower altitudes). Such combat without airborne radar was largely a matter of chance. Over time, however, specialist radar-equipped night fighter units were developed alongside ground control intercept (GCI) stations for air-to-air combat at night. Take off and landing of aircraft at night from carriers remained a problem until late in the war. In the Pacific, the USN introduced night fighter squadrons in January 1944 and USS Independence (CVL-22) a specialist night combat aircraft carrier in August 1944. For these rules only specially trained and equipped air units can conduct air-to-air combat at night.

## Smoke

Ships may produce smoke to reduce visibility and prevent ‘detection’ of ship targets. Gunfire is less effective ( $\times\frac{1}{2}$ ). Smoke is produced over the distance that a ship moves in that turn. Smoke will then drift and disperse iaw the following Smoke Dispersal Table:

### Smoke Dispersal Table

Beaufort	Wind Strength	Drift	Time to Disperse
0-1	Dead Calm	Nil	4 turns (12 mins)
2-4	Gentle	400yds	3 turns (9 mins)
5-6	Moderate	800yds	2 turns (6 mins)
7-8	Rough	1200 yds	1 turn (3 mins)
9-10	Strong Gale	Smoke screens not possible. Ship and air operations limited.	
11-12	Storm	Most ship operations suspended. No air operations.	

## Ship Tactical Movement

All ship models may move up to their maximum speed in knots per 3 minute game turn. In effect this means 1cm move per knot of speed each turn. HMAS *Canberra* moving at 28kn is moved 28cm on the table. During WWII command and control was quite flexible and ship-to-ship communications quite rapid hence it was possible to manoeuvre each ship in tactical combat both rapidly and independently. There are a few physical limitations which have led to the following rules.

Ship's can accelerate and/or decelerate up to 10 knots per turn, so for a ship travelling at 28kn it can only deliberately slow down to 18kn in one 3 minute turn. Of course speed changes due to battle damage (critical hits) over-ride this rule.

Turning circles differ for each ship. For simplicity these rules require ship turning circles to be based upon the actual ship lengths. When turning a ship model advances straight ahead for a distance equal to its own ship length. It is then rotated about its centre by 45 degrees (port or stbd) and the move continued for what is left of the move. To turn 180 degrees – 4 x moves the length of the ship are required along with 4 x turns. Overall the turning circle radius is equal to the ship's length and the turning circle diameter is 2 x ship's length. In this way both the ship's length and speed will affect the turning circle.

The Sea State also affects naval tactical movement. The Beaufort Sea State Table presented above lists the effect of sea states on ship and air operations. In summary:

Beaufort Scale	0-5	Calm/Gentle	No effects.
	6-8	Moderate/Rough	Up to 10% loss in 'Recognition' and up to 30% loss of speed/fire.
	9-12	Strong Gale/Storm	Up to 80% loss in 'Recognition' and up to 80% loss of speed/fire.

Note that most ships did not participate in tactical combat during strong gales, storms or cyclones.

### Radical Manoeuvring

During WWII ship's captains often used 'Radical Manoeuvring' to minimise hits from enemy gunfire and/or air attacks. A warship using 'radical manoeuvring' must move at its maximum speed. This included chasing bombs, radical turns and unpredictable speeds. Only warships may use radical manoeuvring - auxiliaries and merchant vessels cannot. The result was that attackers had great difficulty in preparing/prediction fire plots as the targets frequently changed direction after the missiles were launched. 'Radical Manoeuvring' is simulated in these rules by halving the overall 'hit' percentages for gunfire and air attacks. The ship using 'Radical Manoeuvring' also is penalised having its defensive gunfire and AA fire halved, due to their own inability to predict accurate fire plots.

Ships may also zigzag to reduce the likelihood of torpedo attack. This is not to be confused with radical manoeuvring. There are no halving of percentages for zigzagging. Rather a zigzag involves random course changes at prescribed times along a route that will confuse the firing calculations of an enemy inputting range, course and speed into their torpedo fire solution. Zigzagging disrupts this process and forces the attacking submarine captain to recalculate a solution. In these rules zigzagging is simulated during the torpedo fire mechanism.

## **Aircraft Tactical Movement**

All aircraft models may move up to their maximum speed in knots per 3 minute game turn. In effect this means 1cm move per knot of speed each turn. A flight of 3 Kate torpedo planes moving at 204 nautical miles per hour (knots) moves 204cm on the table per turn (3 mins). During air combat, particularly attacks against ships, aircraft will use their maximum speeds to reduce the time under AA fire, and they coordinate attacks so that attacks are simultaneous to minimise exposure to AA fire due to sequential attacks. As aircraft tactical move distances are much longer than ship moves it is necessary for the player to reveal their course, height and speed before placing them on the table in their position at the end of the turn. This will enable defence AA fire to be calculated. 'Detection' distances apply during this movement, so not all ships within firing range may be able to issue defensive AA fire. Whenever both sides have aircraft involved in tactical combat, each player rolls (D10) for initiative and the higher roll goes first.

When aircraft attack surface targets (ships and/or bases) the ships move before the air groups. Aircraft, forming the air group, then conduct their movement until they reach a position 2000yds (20cm) from the ship they are attacking. Air attack combat is then resolved – including revealing type and path of proposed attack, supporting and defensive AA fire, resulting attacks (level bombing, dive bombing, torpedo and strafing attacks), and remaining aircraft movement (the remaining move distance per turn). Whenever there is more than one air attack against the same enemy ship, the attacking player decides the order in which each air group attacks while the defending player decides what proportion of its ship's AA fire to direct against each air group. Note a defending ship can never fire more than 100% of its AAFF per turn.

During defensive AA fire attacking aircraft may need to turn away. This involves a 180 degree turn followed by a movement (the remaining move distance per turn) directly away from the major concentration of AA fire. Note all aircraft movement is very flexible and each pilot is assumed to use minor variations in flight positions whenever tactical air combat occurs. As with radical manoeuvring by ships, much of this is too small to see on the table.

All aircraft movement also involves plotting their altitude. Basically, it takes one turn (3 min) for an aircraft to take off and reach, say 1000ft, at low altitude (LA). It takes another turn (3 min) to reach 15,000ft at the cusp of high altitude (HA). It would then take another turn (3 min) to reach the aircraft's maximum altitude. So a Zeke (A6M-2) fighter taking off from its carrier would take 9 minutes to reach its maximum altitude of 32,810ft. Note this may not be factually accurate but it does provide a simplified version of the truth.

In addition, the time between take off for aircraft from an aircraft carrier or base is 30 seconds. That means that it would take at least 3 turns of tactical combat (9 min) to launch a readied squadron of 18 aircraft. During campaign movement the aircraft launch rate is not just the time to take off, but includes the readying of all associated airfield crew, support equipment and auxiliaries. For example they could be waiting for a fuel truck for 20 minutes!

### **Submarine Tactical Movement**

Submarine movement on the surface is conducted in the same manner as other surface vessels. When operating below the surface, at periscope depth, normal depth or deep depth), the submarine movement is recorded on a Submarine Tactical Movement Plot. The tactical movement of submarines is discussed in more detail in the related submarine section of the rules below.

## NAVAL TACTICAL SURFACE COMBAT

Naval surface vessels may engage in tactical combat using naval gunfire, torpedoes, and ramming. The following sections provide rules for simulating these on the 'table'.

### Naval Gunfire Overview

During World War I (1914-1918) naval gunfire was seen as the primary means of inflicting damage on enemy ships and hence of winning naval battles. To fight and win at sea was the *raison d'être* for most navies and, as a consequence, naval gunnery officers were seen as the elite of each navy. At the beginning of WWI almost all ships fired their main guns locally with a qualified (typically PO or CPO) gunner aiming and firing each gun as well as commanding the gun crew. By 1914 however experiments with fire control and salvo firing demonstrated that improved results followed when a centralised fire control system was used and when all the ship's main guns fired together as a salvo. Fire control, ranging, correction and salvo fire methods developed rapidly and by the Battle of Jutland, in 1916, were almost universal. Local gun control was reserved for emergencies after damage to the centralised fire control system. When the US Navy entered the war in 1917 they were forced to introduce ranging telescopes and fire control instruments in order to rapidly catch-up to the much more accurate centralised firing methods.

Between the wars, methods for using aircraft to spot long range naval gunfire. Almost immediately maximum ranges increased from those limited by visual means, using telescopes and other rangefinders, to the physical propulsive limits of the guns themselves. Many ship's main gun batteries were modified to allow high-angle fire to achieve maximum ranges at times almost double that obtainable in good visibility. Aircraft could accurately and rapidly correct long-range naval salvo gunfire against moving targets outside of visual range by direct communication with the ship's centralised fire control operators. The ship's fire control system had been upgraded to include analog plots of fire missions. By 1939 most large warships carried a few aircraft for this purpose, although they had to rely upon visual means in bad weather or when the aircraft were not available.

Over the horizon detection was also under development and by 1940 early gunnery fire control (GFC) radars started to be introduced. The new radars could locate targets using electromagnetic (EM) means, involving bouncing EM waves off large targets using a transmitter and receiver, and effectively feed inputs into the existing ship centralised fire control systems. Early versions of these GFC radars were able to target enemy ships at ranges up to the limits of the EM waves themselves, while their accuracy was also limited by the available power, the size of the target, the

amount of interference and their processing ability. By 1944-45, however, relatively sophisticated radars had been developed along with better fire control plotting machines. By 1945 some US Navy battleships were able to use their GFC radar with associated analog computers and fire plotting systems, to identify and hit blind targets with a 15 yard accuracy at a range of 45,000yds. At that time the Imperial Japanese Navy was still using early types of GFC radar, similar to that used by the German Navy's *Bismarck* in 1941.

The following rules aim to simulate this complex evolution of naval gunnery - from local control, to centralised salvo fire, to aircraft spotting assisted fire, to early radar assisted fire control, to late-war advanced technology involving radars and associated fire control plots. During WWI naval gunnery aimed to gradually destroy enemy ships through attrition. At the beginning of WWII, naval gunfire was much more deadly, more accurate and more destructive, but its effects were still somewhat random. By 1945 naval gunfire was simply deadly.

### **Surface Combat – Naval Gunfire Hit Probability**

All of a ship's guns, which are able to bear, can fire whenever an enemy ship is both detected and within maximum gunnery range. All naval tactical gunnery is conducted by battery – ie. all available 8-inch guns per ship. The range is measured from the bow of the firing ship to the bow of the target ship. The number of guns able to fire is determined by looking at the individual arcs of fire for every gun attempting to shoot. Where it is not clear whether a gun or guns may fire then always assume they cannot. The procedure for simulating naval gunfire follows.

1. Firer states intended fire – types of gun, numbers firing and targets. eg. firer can only fire bow guns at targets ahead of them.
2. Measure range in yards and determine ship target factor (STF) and target speed (kn). The full STF is used for side targets while the reduced (0.66) STF is used for bow/rear views of target (up to 30 degrees either side approx).
3. Consult Naval Gun tables to determine the gun factor (GF) per gun firing.
4. The GF is modified by table below – increased by the Target's Size modifier, decreased by the Target Speed modifier, decreased by the Target Range modifier, and by the other modifiers listed.
5. Then multiply this modified GF by the number of guns able to fire, to determine the basic hit percentage.
6. Rate of fire for battery guns. For 12-inch to 18-inch guns x 1. For 5.9-inch to 11-inch x 2. For 3-inch to 5.5-inch x 3. The overall hit percentage then is basic hit percentage x the rate of fire.

At this stage two D10 die are rolled to see how many naval gunfire 'hits' occur. Noting that an overall hit percentage of 125% is one automatic hit and a 25% change of a second hit.

#### **Naval Gunfire Hit Modifiers**

Target Size modifier - calculate and add  $(STF - 15)/2$  to the hit probability.

Target Speed modifier - calculate and subtract  $(Knots - 15)/2$  from the hit probability.

Target Range modifier - subtract 1% from the hit probability for every 1,000yds range.

If the target ship is conducting 'radical manoeuvring, the hit probability is halved ( $\times \frac{1}{2}$ ).

If the target ship is behind a smoke screen, the hit probability is halved ( $\times \frac{1}{2}$ ).

Radar - Early War Gunnery Radar in use +10%, or Late War Gunnery Radar +20%

Spotting Aircraft used to assist gunnery +10%

## Surface Combat – Naval Gunfire Hit Determination

Every gun ‘hit’ has an effect on the target ship, either a standard hit or a critical hit. For all warships, designed and built to naval standards, a roll of D6 – 4, 5 or 6 means a standard hit while a 1, 2 or 3 means a critical hit. For all merchant vessels, auxiliaries and naval vessels either taken up from trade or designed and built to commercial standards, all naval gunnery hits are critical. The results of each of these hit types are determined differently.

HMAS *Canberra* scores 2 hits on the Japanese cruiser *Tenryu*. Rolling 2xD6 gives 3 & 4 – one standard hit and one critical hit on the *Tenryu*.

### For Standard Hits (50% of hits for warships only):

Standard hits represent the gradual accumulation of damage caused whenever a ship is hit by naval gunnery. Standard gunfire essentially generates a gradual attrition of a ship's strength. For armoured warships the hit causes ED points only. For unarmoured warships, auxiliaries, and merchant vessels the hit causes ID points (or 3 x ED points).

All damage caused by naval gunnery hits (found in the Naval Gun Characteristics tables) are taken away from the target ship's ‘damage point’ total as listed in the ship characteristics.

### For Critical Hits:

Critical hits involve specific damage resulting in reduced combat capabilities and/or performance. Critical hits also include those causing ongoing damage due to fire or flooding as well as any longer term or more permanent loss or damage to ship systems or hull. The Critical Damage Tables (CDTs) and the list of Critical Damage Effects (CDEs) apply.

The effect of critical hits are determined by rolling 2xD10 percentage dice and consulting the relevant Critical Damage Table (CDT). The damage from each hit is read off the chart using the tens (0-9) and the units (0-9) die rolls for each type of target ship fired at. Separate CDTs for naval gunnery are provided for Large Warships (25 STF or more), Small Warships (24 STF or less), CVs, CVLs and CVEs, Merchant Vessels & Auxiliaries, and Submarines. The resultant critical damage is given in the Critical Damage Effects (CDEs) listing.

Often an armour class is stated in the CDT, this means that the armour has to be penetrated before the subsequent critical damage results. Whenever stated armour cannot be penetrated only the ED damage applies (as per a standard damage hit). So small calibre gunfire cannot hit a main magazine behind armour and cause a warship to explode! Whenever the critical damage is not possible due to actual ship characteristics, ie. when there are no Torpedo Tubes onboard to explode, then the critical damage is ignored and only ID or ED damage points are caused.

Heavy naval guns have no limitations wrt the Critical Damage Effects listed above, however medium naval guns (6 to 10-inch guns) and small naval guns (<5.6-inch) have limitations on the damage they may cause. Medium guns cannot cause Serious fires/flooding on Battleships (BB) – all such effects are reduced to major fires/flooding. Small guns

cannot cause Serious or Major fires/flooding on BB, CA or CL – all such effects are reduced to minor fires/flooding. Torpedo and aerial bombing hits have no such limitations.

Note that CDTs are also used for determining the effects of hits by ship and air launched torpedoes, aerial bombs, and other forms of combat hits.

### **Naval Torpedo Overview**

During World War I the torpedo became the great equaliser in naval combat. Whereas much of the public imagination had centred upon the Dreadnought Race and a decisive naval battle between battleships firing their guns at each other, many naval professionals had raised concerns about the use of the relatively cheap, mass produced torpedo by flotilla craft and submarines. Indeed whereas naval gunfire was seen as a slow means of sinking enemy warships through attrition, torpedoes hit warships below the waterline where it hurt and where warships would sink themselves.

Warship designers soon learnt that it was possible to mitigate against likely torpedo damage. Initially torpedo bulges were added to ships but these soon evolved into double or triple hull warship designs. Torpedo damage to the outer hull would not penetrate an internal hull. In addition internal watertight compartments were used to limit any flooding caused by an underwater explosion. The size of a warship itself contributed to its ability to minimise torpedo damage. Operationally, warship crews were also trained to stop flooding by using damage control methods and to counterflood compartments in order to maintain stability. Warship damage control parties were also specially trained to overcome such flooding. By using these methods the ability of larger warships to survive torpedo damage was significantly enhanced. Older battleships, smaller warships, auxiliaries and merchant vessels, lacking many of these mitigating design and operating features, were more likely to suffer the effects of torpedo damage.

### **Surface Combat – Torpedoes**

Torpedoes are used to hit ships where it really counts – below the waterline. Warships were equipped with torpedo tubes (TT) mostly in deck mounted TT launchers capable of firing one to six torpedoes – single, dual, triple, quad or five TT launchers - in a single aimed salvo at one target. Some larger and/or older warships had subsurface TTs which also fired as salvos. Submarines also had submerged TTs. Torpedo armed aircraft may also fire aerial torpedoes in salvos when operating in flights up to 6 aircraft (in these rules 7 torpedo planes may only fire torpedoes in two salvos). This rule set, uses a modified *Skytrex* (1981) system – known as the ‘torpedo match’ method.

## To determine torpedo hits:

1. Torpedoes are fired at the beginning of the move, before ship movement.
  1. A 'match' is placed beside the ship firing, for each salvo, at the point of firing.
2. The match is pointed in the direction fired. The target, salvo size and torpedo speed is written down.
3. Both players carry on with ship movement and firing guns. Place a second match down in the position reached by the TT salvo at the end of that turn [ie. 40kn TT moves 4000yds (40cm) from start up to max of 8500yds (85cm)].
4. After all movement and firing, the chance of torpedo hit is calculated using the Torpedo Basic Hit Table & Modifiers section below. The range is measured from the start of the match to the bow of the target (at the time it crosses the TT path).

A torpedo hit is possible only when the TT move (match to match) crosses the path of a ship (target or other) that turn. Ships that zigzag during their move may avoid being hit by torpedoes. Warships torpedo fire is limited, they carry one reload for TTs limiting their torpedo fire to twice per sortie (or game). Reloading TTs takes 5 turns (15 minutes).

### Torpedo Damage Points & Ranges

Type	Damage Points	Short Range	Normal Range	Long Range
18-inch (incl. aerial torpedoes)	600 pts	3,500yds @ 40kn	-	-
19-inch (Fido homing A/S torpedoes)	100 pts	4,000yds @ 12kn	-	-
21-inch	800 pts	8,500yds @ 40kn	12,000 yds @ 35 kn	15,000 yds @ 30 kn
22-inch (USN aerial torpedoes)	600 pts	6,000yds @ 34kn	-	-
24-inch (Japanese type only)	1600 pts	24,000yds @ 49kn	42,000 yds @ 36 kn	-

Torpedo salvos run until they reach their max range – so the matches need to stay in place. For 21-inch TT runs this may be up to 5 turns (15 minutes), while for Japanese 24-inch TT runs may be 12 turns (36 minutes).

The above rules are a simplification of the numerous types of torpedo actually used by the warring nations. Noting that some nations had technical difficulties with their torpedo production, testing and functioning, individual national details are not considered necessary. It is possible to replace the above characteristics with national characteristics for each type of torpedo actually used, in a manner similar to the naval gunnery data tables. Anyone wishing to do so, will have to do the research and gain agreement before the campaign and/or naval action starts.

## Torpedo Basic Hit Table & Modifiers

The following table is used to determine the basic percentage chance of torpedo salvo hits. This is based upon torpedo hits obtained in trials using a 300ft OA (STF 15/10) ship target @ 15 knots. The basic hit percentage is then modified for target size and speed.

Torpedoes in Salvo		up to 4000yds	6000yds	8000yds	12,000yds	20,000yds	34,000yds	42,000yds
1	(1 hit)	0-50%	0-30%	0-10%	0-5%	-	-	-
	(2 hits)	-	-	-	-	-	-	-
2	(1 hit)	26-55%	6-35%	0-15%	0-7%	0-5%	-	-
	(2 hits)	0-25%	0-5%	-	-	-	-	-
3	(1 hit)	31-60%	11-40%	6-20%	0-10%	0-7%	0-5%	-
	(2 hits)	0-30%	0-10%	0-5%	-	-	-	-
4	(1 hit)	33-65%	13-45%	8-25%	6-12%	0-7%	0-5%	-
	(2 hits)	0-32%	0-12%	0-7%	0-5%	-	-	-
5	(1 hit)	36-70%	16-50%	11-30%	6-15%	6-10%	0-7%	0-5%
	(2 hits)	0-35%	0-15%	0-10%	0-5%	0-5%	-	-
6	(1 hit)	36-75%	18-55%	13-35%	11-17%	8-10%	0-7%	0-5%
	(2 hits)	0-37%	0-17%	0-12%	0-10%	0-7%	-	-

### Torpedo Hit Modifiers

Target Size modifier - calculate and add  $(STF - 15)/2$  to the hit probability.

Target Speed modifier - calculate and subtract  $(Knots - 15)/2$  from the hit probability.

If the target ship is conducting 'radical manoeuvring, the hit probability to halved ( $\times \frac{1}{2}$ ).

If the target ship is behind a smoke screen, the hit probability is halved ( $\times \frac{1}{2}$ ).

When a homing torpedo is used or a pattern running device is fitted, the torpedo hit probability is doubled ( $\times 2$ ).

Range modifier for aerial 18 & 22-inch torpedoes - add 5% to the hit probability for every 1000yds less than 3500yds, (ie. 500yds + 15%, 1500yds +10%, 2500yds +5%). Minimum is 300yds.

Range modifier for submarine launched 18-inch & 21-inch torpedoes - add 10% to the hit probability for every 1000yds less than 3500yds, (ie. 500yds + 30%, 1500yds +20%, 2500yds +10%). Minimum is 300yds.

Example: Target is HMAS *Sydney* STF 25/16 at 32kn. Torpedo aimed at port side, STF = 25. So add  $(25-15)/2 = + 5\%$  to hit probability. Speed subtract  $(32-15)/2 = - 8 \frac{1}{2}$  (rounded down to - 8%). Speed modifier means - 8% from hit probability. Now if aerial torpedo fired at 500yds also +15%. Total modifier is +12 per torpedo to hit probability.

## Torpedo Critical Hit Effects

As with gunnery hits, torpedo hits may cause the standard torpedo damage points (roll of 4,5,6 on D6) as shown above. In addition torpedo hits are critical 50% of the time (roll 1,2,3 on D6). Note all homing torpedo hits are Critical Hits. Consult the Critical Hit Determination (CDT) table for torpedoes to determine the results. For this table the target's Torpedo Rating (TR) is used against a D10 dice roll to determine the resulting Critical Hit Effect. Note that the chance of sinking is quite high for merchant vessels and smaller vessels designed to commercial standards, (TRs 'A' & 'B'). During WWII these included numerous commercial grade vessels built under wartime emergency measures. The highest TR is 'H' which applies to heavily protected warships designed and built to naval standards and upgraded to reflect wartime experience. These ships had extensive anti-torpedo protection (bulges, armour belts), neutral gas holding charges in fuel tanks, compartmentalisation, system redundancies and physical separation, shock protection, extensive damage control systems and similar survivability features -

eg. *Iowa* class battleships. TR ‘H’ ships require many torpedoes to hit and cause damage before they will sink.

### **Ramming of Surface Vessels & Submarines**

Ramming was generally avoided by surface vessels. The main exception was when a vessel purposely rammed an enemy submarine seen running on the surface. Submerged submarines or submarine periscopes cannot be rammed. Sometimes a fast moving warship did accidentally ram an unseen friend or enemy vessel (such as a patrol boat in the dark). A third cause of ramming was when friendly ships accidentally hit each other during a manoeuvre.

Whenever two surface vessels appear to hit or are close to hitting each other during movement on the table, whether deliberately or accidentally, there is a chance of a ramming. (This may involve some discussion between players or even a D6 die roll to determine. Once they appear to hit the chance of a hit by ramming is rolled using percentile dice. If a ramming hit occurs damage is calculated for each vessel iaw table below. Both vessels suffer the same damage, unless one is clearly ramming with its bow into the mid-section of the second ship, in which case the ramming ship’s damage is halved. All ramming hits on a submarine are critical hits and need to be rolled for on the Critical Results Determination table.

#### **Chance of Ramming Hit**

Submarine Ramming Attempt	80%
Accidental Unseen Ramming	50%
Accidental Ramming in Manoeuvre	20%

**Damage due to Ramming** (pts) = Ramming vessel’s (STF + speed in kn) x 10, or the smaller ship’s damage pts  
For damage use whichever value is lower

### **Small Calibre Fire against Minor Vessels**

Surface ships may use their light calibre guns (under 3-inch), cannons and machine guns, which are normally used for anti-aircraft fire, in high-speed firing attacks (strafing), to damage or destroy minor vessels (trawlers, MTB, PT, and the like). Ships wishing to strafe use their Anti-Aircraft Fire Factor (AAFF) to automatically hit their opponents causing damage up to or equal to their AAFF per turn. The AAFF ranges and divided fire rules apply, just like aircraft, but with enemy minor vessels (see Anti-Aircraft paras below). For example an Italian armed gunboat with AAFF 08 (2x3-inch & 4xHMG - 385pts) is attacked by three Greek MTBs (T3 - 32pts), with AAFF 01 each, at close range (<1500yds). Opting to strafe the gunboat causes 8pts damage on one of the MTBs. Returning fire they together cause 3pts. Ships choosing to strafe can split their fire but cannot fire more than their maximum AAFF in a turn. In addition, if they opt to fire their 3 to 6 inch HA/DP guns individually they cannot use the same guns again in a strafing attack. Strafing cannot cause critical hits.

Strafing may not appear to be important, however it is effective when used by larger warships to sink MTBs that get too close. For example, if the same 3 three Greek MTBs attacked the Italian light cruiser *Giuseppe Garibaldi* (AAFF 52) at 1000yds. The CL would automatically cause 52pts damage on the MTBs – sinking one and damaging a second, or choose to split these damage points over the three vessels. The surviving MTBs if possible could then fire torpedoes at the cruiser. Fast attack craft were not suicide vessels and hence would rarely if ever attack surface vessels when they had a high (over 20%) chance of death!

### **Carrier Operations after Damage**

Carrier air operations are affected whenever the carrier's damage points are reduced by 25% or more. When 25% damage occurs the LF is reduced by 9/3. For 50% damage the LF is reduced by 18/6. Aircraft cannot land or take off from a carrier with a LF reduced to 0. AVs, CAVs, BBs & other seaplane carrying vessels reduce their RF by 3/3 whenever they suffer 25% damage.

In addition every time 10% damage is caused 20% of the aircraft on the flight deck(s) (ready or just landed) are also hit. For each roll a D6 - 1,2 destroyed, 3,4 damaged, 5,6 minor damage (requiring 6 hours to repair).

Whenever an aircraft carrying ship is sunk, its complement of aircraft is also lost. Any aircraft that is in the air at the time may attempt to land on an adjacent carrier or fly to the nearest base, however such aircraft can no longer form part of a naval campaign.

### **Surface Vessel Morale**

Whenever a surface vessel loses 1/3 of their damage points, they must roll a D6 for morale – 1,2, the ship withdraws out of range and tries to avoid combat, 3,4,5&6 the ship continues in the fight. When a surface vessel loses 2/3 damage points, they must roll a D6 for morale - 1,2 the ship must withdraw from combat and return to its base or the nearest protected harbour. 3,4 the ship must withdraw out of range and try to avoid combat until the action is over. 5,6 the ship fights on regardless.

## NAVAL TACTICAL AIR COMBAT

The air above the surface of the sea is an important component of naval tactical combat. Observation and detection from the air has already been discussed, The following rules cover: air-to-air combat, anti-aircraft fire, and air attacks on surface vessels (including bombing, torpedo attacks and strafing).

### **Air Combat: Air-to-Air**

Tactical air-to-air combat between aircraft, involving manoeuvre and firing in three dimensions is not covered within this naval rules set. Those seeking such 'dog fighting' rules are asked to refer to rules such as the classic *Air Force* 1976 and *Dauntless* 1978 board games or similar. That said it is sometimes necessary to determine the results of air-to-air combat for the naval tactical game to proceed.

This NAVSIM rule set uses a modified version of the *Flat Top* (1977) rules for air-to-air combat, although for these rules actual numbers of aircraft (not a 3:1 scale) apply. For further details refer to the campaign air operations section above. All aircraft carriers and bases have a maximum capacity of aircraft (MC), a normal launch factor (LF), a minimum launch factor, a maximum launch factor, and a readying factor (RDF). Aircraft are moved between aircraft boxes [in flight, just landed, readying, ready (armed) and dispersed], depending on the limitations of the CV or airfield. Air Groups are written down consisting of aircraft type, the number of aircraft in the AG, their altitude (HA or LA), whether they are Interceptors, Escorts, or Bombers, as well as the armaments carried (GP bombs, AP bombs, or torpedoes). Campaign movement of Air Groups is by map movement with each aircraft type moving up to their maximum Movement Factor (MF) each hour, and moving up to their maximum Range Factor (RF) – maximum hours in the air. Note for each hour the aircraft is engaged in combat it costs the aircraft an additional RF point, (high altitude bombing is exempt from RF reductions).

For air-to-air combat each Air Group is matched against their opponents. Aircraft Attack Factors (AF) and Defence Factors (DF) are determined using the appropriate data tables and compared. All aircraft combat occurs at high altitude and/or low altitude – aircraft cannot move between these altitudes during air-to-air combat. Air-to-air combat is conducted in two parts – firstly Interceptors vs Escorts, and secondly (if remaining Interceptors outnumber Escorts by 2:1) Interceptors vs Bombers. Each is a separate air-to-air combat in the same (one tactical combat) turn.

Aircraft or squadrons cannot engage in tactical combat when they pass enemy aircraft on route to a target. Tactical air combat may only occur within 45nm (max. radar range) of a Task Force (including individual ships/submarines) and/or a Base.

Later in the war naval aircraft could be ‘vectored’ out by a ship based Combat Information Centre (CIC) to contact enemy aircraft groups using a ship’s air search radar to control aircraft - including the Combat Air Patrol (CAP). this is discussed further under the Naval Command section.

The rules for air-to-air combat follow:

Step 1: **Avoid Combat:** check for aircraft wishing and able to avoid tactical combat. Altitudes have to be the same otherwise combat cannot proceed. Aircraft cannot change altitude during a turn. Related speeds have to be checked. Faster aircraft may opt to avoid combat.

Step 2: **Calculate percentage chance of hits** and roll dice to obtain number of hits: chance of hit = AF/DF (a/c attack factor / enemy a/c defence factor). The aircraft data sheets accompanying these rules give AF and DF values for relevant aircraft. The AF/DF percentage is modified (if reqd), and then multiplied by the number of aircraft involved in the combat. Both sides fight air-to-air at the same time. Roll % dice to determine air-to-air hits.

**Modifiers:**

If fighters attack non-fighter aircraft	+10%
If fighters attack armed aircraft	+20%
If opponent not defended or is damaged	+20%
At night	- 8%
Using cloud cover	- 4%

Step 3: **Aircraft Hit Determination** – apply the 1/3 rule. Roll D6:

If 1,2 aircraft destroyed/shot down: 3,4 aircraft damaged: 5,6 aircraft turns away.

When calculating the chance of hits during tactical air combat, each tactical air combat must be between aircraft of the one type – ie. Zero vs Wildcat, and never a mix of types. The squadron is the maximum unit size capable of conducting tactical air combat. Note this is due to limitations in command, control and communications, so a mixed squadron formed for a particular mission acts like a normal squadron.

The maximum altitude for anti-aircraft fire is 30,000ft. In these rules only eligible aircraft determined to fight each other in air-to-air combat may do so at altitudes above 30,000ft. Those aircraft holding the altitude advantage may always opt to use Step 1 to avoid combat by going higher than their opponents. This was a decided advantage for some reconnaissance aircraft.

### **Follow-up on Air-to-Air Combat**

Remember that air-to-air combat occurs in two separate parts - when Interceptors vs Escorts combat is completed, if the remaining Interceptors outnumber the Escorts by 2:1, then Interceptor vs Bomber combat is conducted.

Whenever aircraft participate in tactical air-to-air combat, either in attack or defence, they expend fuel and ammunition. Aircraft may participate in three standard combat turns per sortie. That is they can only participate in 3 game turns (3x3mins). This is the equivalent to expending a Range Factor (1 hour) in the

campaign hourly move. Once the standard combat turns have been used the aircraft are undefended if attacked. Aircraft damaged by a hit in combat and returning home are undefended. This means that only the attackers can roll for chances to hit in air-to-air combat. If a bomber decides not to participate in air-to-air combat even when attacked by an interceptor, the bomber does not lose a standard combat turn. That bomber is however considered an undefended aircraft in combat (+20%). Of course bombs and torpedoes may be jettisoned prior to combat.

An aircraft that was damaged, or had to turn away in air combat and has then decided to go home instead of continuing the attack, may be pursued by 1 to 3 enemy fighter aircraft in the next 3 minute turn. In response the first player may interdict the pursuers with up to 3 times as many aircraft as the enemy, in an effort to help defend their withdrawing colleagues. In this way a follow-up air-to-air combat may result.

Once air-to-air combat is resolved, the remaining aircraft may undertake tactical movement onto the table. When aircraft attack surface targets (ships and/or bases) the ships move before the air groups. Aircraft then conduct their movement as revealed until they reach a position 2000yds (20cm) from the ship they are attacking. Air attack combat is then resolved – including revealing type and path of proposed attack, defensive AA fire, resulting attacks (level bombing, dive bombing, torpedo and strafing attacks), and remaining aircraft movement (the remaining move distance per turn). Aircraft always move at their maximum speed during such attacks unless they are launching an attack with weapons requiring slower speeds for delivery.

### **Air Combat – Anti-Aircraft Fire**

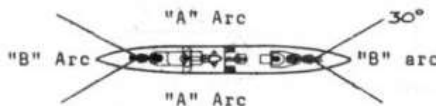
Anti-Aircraft (AA) Fire from the ship under attack and supporting ships within range may cause damage to the attacking aircraft before those aircraft can drop their bombs, torpedoes or strafe. AA Fire from supporting ships within range as the aircraft conducts tactical movement towards the ship target. Supporting AA Fire against high altitude (HA >15,000ft) aircraft is limited to Long Range Guns (3-inch to 6-inch AA guns). Supporting AA Fire against low altitude (LA) aircraft is limited to those ships with clear arcs of fire away from their own Task Force, ie. able to fire without friendly ships in the vicinity. What is left of the attacking Air Group (AG) is then placed at a position 2000yds (20cm) from the target ship in the direction of their approach. Defensive AA Fire, from the target ship, is then calculated firstly for the aircraft's 'approach' to drop (launch/fire) position, and secondly for the aircraft's 'departure' from the target. The aircraft's total movement is made up of the initial move to the 2000yds position, the approach to the drop position and the subsequent departure move.

Anti-aircraft and high altitude guns are divided into the following categories.

Gun	Range	Altitude	AA Point Factor
3-inch to 6-inch	Long 10,000yds	up to 30,000ft	3
31mm to 40mm	Medium 5000yds	up to 15,000ft	2
12mm to 30mm	Short 1500yds	up to 4,500ft	1

High Altitude (HA) is 15,000ft to 30,000ft. Low Altitude (LA) up to 15,000ft.

A ships defensive Anti-Aircraft Fire Factor (AAFF) is calculated by adding all the ships AA Point Factors together. AA Fire is limited by fire arcs as well as by gun type and range. AA Fire arcs are shown on the accompanying diagram. Each 'A' Arc can fire up to 50% of AAFF. Each Bow and Stern 'B' Arc can fire up to 25% of AAFF. When an air attack flies from port to stbd before it departs it is subjected to 2x50% AAFF fire – one before dropping armaments and another one after the attack. The total AAFF fire per turn cannot exceed 100%. The approach and withdrawal of each air attack matters!



#### Anti-Aircraft Fire Modifiers:

Aircraft in clouds -10%,

Aircraft at night -20%.

Firing at armed torpedo bombers at LA +10%,

Firing at armed dive bombers at LA -10%.

If ship is using 'radical manoeuvring' all AA fire percentages are halved.

Each ship's AA fire percentage is calculated using the AA points eligible to fire corrected using the above modifiers.

Examples: a merchant vessel with 2x3-inch AA gun (AAFF 06) can provide AA Supporting Fire at enemy bombers at HA flying past at a range of 9000yds, The 'A' arc AA Fire hit percentage is then 50% of AAFF = 3%. Roll 2 x D10 to obtain 01 – 03 result. If the same aircraft at HA fly past within range of a Heavy Cruiser with 8x4-inch Dual Purpose (DP) guns (AAFF 24), the 'A' arc fire gives 12% chance to hit. Now say 3 torpedo bombers, at LA and 14000yds range, fly past the same Heavy Cruiser with 8 x 4-inch, & 16 x 2pdr(40mm) Quick Fire (QF) Pom Pom – (AAFF 40). The cruiser may give supporting AA fire at 'A' arc of 20% with +10% modifier = 30% change to hit one aircraft.

#### Aircraft Hit Determination

The 1/3 rule applies to all tactical air combat hits. A D6 is rolled. If 1, 2 roll then the aircraft is shot down and destroyed, If 3,4 the aircraft is damaged, it must release weapons and return to CV/base. If a 5,6 roll occurs the aircraft must turn-away. This movement is 180 degrees away from the target for what remains of the move. In such situations the aircraft that turned-away may attack once again the following move. Such lone aircraft follow-up attacks are much more risky.

One of the important naval aviation lessons learnt during WWII was that although there was a small chance that a few aircraft could cause significant damage, squadrons of aircraft working together almost guaranteed results. In turn to minimise hits to aircraft and still achieve the damage effects aimed for required overwhelming air strength – often involving 100s of aircraft.

Note that whenever these tactical air combat rules are used all actions and hits are for single aircraft. When the *Flat Top* campaign rules are used then air factors representing 3 aircraft apply.

### **Air Combat – Air Attack Combat**

All attacking aircraft that survive air-to-air combat and/or AA fire, may proceed to Air Attack Combat. Such tactical combat involves: Level bombing at high altitude, Level bombing at low altitude, Skip bombing, Dive bombing, Torpedo bombing and Strafing. The attacking player must prepare each form of air attack during the readying phase prior to take off, including whether Armour Piercing (AP) or General Purpose (GP) weapons are carried on bombing missions.

Definition: For these rules - High Altitude (HA) is 15,000ft to 30,000ft. Low Altitude (LA) up to 15,000ft.

Level bombing of ships from HA involves aircraft flying between 15,000 and 30,000 feet and using bomb aiming instruments to target the enemy ship. They also fly straight and level in formations aimed at covering an area with bombs. Such bombing is not very accurate however it is the safest from AA fire and, unlike other forms of air attack, the aircraft involved do not lose any flight time/range (no RF deduction). For all HA level bombing the full STF is used for the target ship. All aircraft tactical movement is at High Altitude.

Level bombing of ships from LA involves aircraft flying below 15,000ft using bomb aiming instruments to target a ship. They also fly straight and level in formations aimed at covering an area with bombs. Although more accurate than HA level bombing, LA bombing was limited in its ability to hit a moving target. For all LA level bombing the STF used for the target ship depends on the angle of attack. All aircraft tactical movement is at Low Altitude.

Skip bombing was used against ships with LA aircraft flying just above the water dropping bombs that skipped across the surface (like a thrown stone) aiming to hit the side of the target ship. This method needed a high degree of pilot/crew training and practice to be effective. Skip bombing was used by the Italian, British, Soviet and American navies. For all skip bombing the STF used for the target ship depends on the angle of attack. All skip bombing aircraft tactical movement is at Low Altitude.

Dive bombing involved aircraft approaching the target ship at HA and when in position rapidly diving at a steep angle to a very low altitude before releasing their bombs. Once released the bombs continued to dive to hit the target while the aircraft pulled out of the dive and rapidly exited the area at LA. Once again dive bombing required a high degree of pilot/crew training and practice. Dive bombing

tests confirmed that this form of air attack on ships was the most accurate. For all dive bombing the full STF is used for the target ship. In addition the dive itself reduced the effect of AA fire. All dive bombing aircraft start their tactical movement at High Altitude and dive to Low Altitude before their 'departure'.

Torpedo bombing was used against ships with LA aircraft flying just above the water launching aerial torpedoes which moved just beneath the sea surface to hit the target ship. Torpedo bombing was very effective, although the straight, slow approach by the torpedo aircraft left them susceptible to AA fire. For torpedo bombing attacks the STF used for the target ship depends on the angle of attack. All torpedo bombing aircraft tactical movement is at Low altitude.

Strafing of ships was conducted by fast fighter type aircraft flying at LA. For all strafing attacks the STF used for the target ship depends on the angle of attack. This was a highly risky and relatively ineffective activity but did occur successfully at times.

### **Aerial Bombing Basic Hits & Modifiers**

The following percentages are used to determine the basic chance of aerial bombing hits. This is based upon actual bomb hits obtained in trials using a 300 ft oa (STF 15/10) ship target @ 15 knots. The basic hit percentage is then modified for target size and speed.

<b>Form of Air Attack Bombs Dropped</b>	<b>Dive Bombing (AP &amp; GP)</b>	<b>Skip Bombing LA (AP &amp; GP)</b>	<b>Level Bombing LA (AP &amp; GP)</b>	<b>Level Bombing HA (AP &amp; GP)</b>
Chance of hit per bomb	30%	20%	5%	1%

#### **Bombing Hit Modifiers**

Target Size modifier - calculate and add  $(STF - 15)/2$  to the hit probability.

Target Speed modifier - calculate and subtract  $(Knots - 15)/2$  from the hit probability.

If the target ship is conducting 'radical manoeuvring, the hit probability is halved ( $\times \frac{1}{2}$ ).

If the target ship is behind a smoke screen, the hit probability is halved ( $\times \frac{1}{2}$ ).

The percentage chance to hit of each bomb, after modifiers, is then multiplied by the number of bombs (of the same size) dropped by all the aircraft in the Air Group. The resultant percentage is the Overall Chance to Hit with that size bomb.

Aerial bombing hits may cause the standard damage points (equivalent to the weight of the bomb) with roll of 4,5,6 on D6. In addition aerial bombing hits are critical 50% of the time - with a roll 1,2,3 on D6. Consult the Critical Hit Determination (CDT) table for bombing to determine the Critical Hit results. For this table the two D10 dice are rolled to determine the Critical Hit Effects.

Only AP (armour penetrating) bombs can cause Critical Damage against ships. All aerial bombs penetrate up to 6-inches when they hit the deck (A2), turrets (A3/A4) and/or vital (A5) armour. All bombs can only penetrate up to 3-inches of belt (A1) armour. Any AP bomb penetrating to the ship's interior causes 3xbomb weight (in lbs) as ID pts. When GP (general purpose) bombs are used against ships they cannot penetrate any armour, hence only external damage (ED) is caused – 1xbomb weight (in lbs). GP bombs cannot cause Critical Damage against ships.

Example: a B-17 Flying Fortress armed with 20×500lb bombs conducts a HA level bombing attack on the CA - HMAS *Canberra* STF 28 at 25kn. Size modifier is +6. Speed modifier -5. So total modifier is +1. Basic percentage is 1% so modified is 2% per bomb. 20 bombs gives 40% chance of a 500lb hit. If *Canberra* was using 'radical manoeuvre' it would be just 20% chance of one 500lb bomb hit. Also if *Canberra* was at 31kn gives Speed modifier -8. Basic percentage is 1% modified is -1% so it is not possible to hit with HA level bombing at that speed.

### **Aerial Torpedo Bombing against Ship Targets**

Aircraft attacking ships with torpedoes do so at LA launching a single torpedo in a 3 minute turn. Each aircraft within an Air Group (up to 6 a/c) of the same type may fire as part of a salvo torpedo attack. Torpedo aircraft move at LA until a position of 2000yds from their target. The attacker must state the torpedo launch range and a match is put down on the table. Having survived AA fire, the surviving aircraft 'approach' and launch their torpedoes at which time the chance of a torpedo hit is calculated. The aircraft then 'departs' by moving what remains of their movement that turn. Aerial torpedo bombing is conducted using the same method as that used for ship launched torpedoes.

Aerial torpedo bombing is conducted using 18-inch torpedoes @ 40kns from a range up to 3500yds. The Torpedo Basic Hit Table and accompanying modifiers are used to determine the probability of a hit. Note that the percentage chance of an aerial torpedo hit increases slightly with reduced launch range. During movement a second match is placed at the distance that the torpedo moves in one turn, ie. 3500yds or 35cms on the table.

Aerial torpedo hits may cause the standard torpedo damage points (600pts) with roll of 4,5,6 on D6. In addition torpedo hits are critical 50% of the time – with a roll 1,2,3 on D6. Consult the Critical Hit Determination (CDT) table above for torpedoes to determine the results. For this table the target's Torpedo Rating (TR) is used against a D10 dice roll to determine the resulting Critical Hit Effect using the same procedure as for ship launched torpedoes.

Airborne homing torpedoes (Mk 24 or Fido) were introduced by the Allies during 1944. They relied upon acoustic and magnetic homing devices to locate the enemy submarine after an aircraft dropped the A/S torpedo in the vicinity. Homing

torpedoes are twice as likely to hit their target as conventional submarines. All homing torpedo hits are Critical Hits.

### **Kamikaze Attacks and Guided Bombs**

Japanese *kamikaze* attacks (1944-45) were essentially human guided bombs. Whenever Kamikaze aircraft are used they have to survive any air-to-air combat, with fighters vectored typically up to 45nm ahead of their ships/bases in an effort to destroy the kamikazes well before they reached any Allied ships. Surviving kamikazes then move as per other forms of attack to a LA position 2000yds from the target ship, and state the direction of their attack. If they survive AA fire the aircraft has a 30% chance to hit its target. The 50% of hits, 1,2,3 on D6, are critical hits on the target with 3 x damage pts. A 4,5,6 is a normal hit with standard damage points. Damage points for kamikaze aircraft is calculated as their 'gross weight (lbs)' divided by 10.

For example a standard Japanese Ki44 fighter (gwt 6598lb) fitted out as a kamikaze would cause 660pts damage standard and 1980pts for critical hit, (1980/660pts).

Experience demonstrated that it was easiest for naval aircraft to destroy kamikaze aircraft at their source, ie. destroy them on the ground at their airfields.

Germany first used an anti-ship guided missile (Hs293) operationally in September 1943. These may be treated as unmanned kamikaze bombs and iaw the rules above.

*German Hs293 Anti-Ship Guided Missile:* monoplane with over 10ft wingspan, weight 1700lb with 683lb charge (2049/683pts). Dropped from Do.217 or He.177 aircraft. Missile range 4,400-22,000yds with air speeds 300-400kn, under radio control from launching aircraft.

### **Strafing Ships**

Aircraft may use their cannons and machine guns, which are normally reserved for air-to-air combat, to strafe the superstructure of ships, small vessels, or surfaced submarines. This could be a very dangerous habit if not well planned and executed as part of a larger scale air attack. Aircraft wishing to strafe move as per other forms of attack to a LA position 2000yds from the target ship, and state the direction of their strafing attack. If they survive AA fire the aircraft automatically hits causing external damage equal to their Air Combat Factor (ACF) x D10 roll. That is result up to 10 times the ACF gives the points damage on the ship. For example three P-40 fighters strafing roll a 6 on D10 and with a ACF of 7 the result is 42 points per aircraft = 126 pts of damage to the target ship results. It is not possible to strafe ships if the aircraft are: armed with other weapons, or are at high altitude. Strafing cannot cause critical hits. For strafing attacks on aircraft carriers, it is assumed that aircraft on deck are the main aiming point – one target aircraft is hit for every 100 pts of strafing damage. Once target aircraft are hit roll D6 to determine damage (1,2 destroyed, 3,4 damaged, 5, 6 no effect).

## **Rocket attacks against Ships**

Aircraft could fire rockets at the superstructure of ships, small vessels, or surfaced submarines. Aircraft wishing to fire rockets move as per other forms of attack to a LA position 2000yds from the target ship, and state the direction of their rocket attack. If they survive AA fire the aircraft has a 30% chance to hit with each rocket, roll 1 or 2 on D6, and to cause 25pts damage (each 3-inch AP rocket) or 60pts damage (each 5-inch rocket). AP rockets may cause critical damage to surfaced submarines. It is only possible to fire rockets at vessels when the aircraft is at low altitude.

For example a RAF 48 Sqn Hudson fires four x 3-inch AP rockets at a surfaced U-boat. Four D6 are rolled and 2 hits result,  $2 \times 25\text{pts} = 50\text{pts}$  damage to the target submarine. As they are AP rockets against a submarine hull a critical roll is necessary – only one hit is critical. Rolling two D10 dice – 8 & 0 - then referring to the Critical Damage Table gives '41'. 'Steering flat wrecked. A2. Ship circles stbd for 3 turns.' The submarine has no armour protection so it takes a total of 75pts (3xbasic) damage from that hit and has to turn stbd for three turns (9 minutes).

In 1944 some British Mosquito aircraft were fitted with 57mm (6pdr AP) cannon in the nose of the aircraft. These were intended to shoot AP rounds (lbs) at surfaced submarine hulls. Such weapons are treated the same as 3-inch rocket attacks causing 25pts damage per turn of 6 pdr fire.

## **Air Attacks on Ships in Harbour, Land Bases and Air Bases**

Air attacks on Land Bases include those against shipping in a port or harbour, those against coastal defences and land forces, and perhaps most importantly air attacks against air fields and aircraft on the ground. Air attacks against ships in port or harbour use the above rules for naval surface combat. Rules for air attacks against coastal defences and land forces are found under the amphibious warfare section. Air attacks on air bases may cause damage to the airfield, its associated infrastructure and/or the aircraft on that base.

## **Air Attacks against Air Bases**

Whenever an Air Group (AG) wishes to attack an airfield or base, or target aircraft on the ground or on the water at a sea plane base, it is undertaken using the same procedure as that used against surface warships which are stationary or anchored. Aircraft can conduct level bombing, dive bombing or strafing attacks against Air Bases, although level bombing may be from either HA or LA. In addition they can drop either GP or AP bombs.

Each air base and/or sea plane base operational during a naval campaign has a number of characteristics (equivalent to ship characteristics) for each specific target. Air base target would typically include airfield (with or without readied and/or just landed aircraft), control positions, aircraft hangars (readying aircraft), AAFF positions, and supply dumps. For each target, characteristics would include a Base Target Factor (BTF), overall damage points, and specialist fire fighting and

airfield repair parties. As a guide a large airfield capable of handling 50 to 60 aircraft would typically have a BTF of 40 with 25,000 damage points (that of a similarly sized CV).

**Aerial Bombing against Air Bases - Basic Hits & Modifiers**

The following percentages are used to determine the basic chance of aerial bombing hits against air base targets.

Form of Air Attack Bombs Dropped	Dive Bombing (AP & GP)	Level Bombing LA (AP & GP)	Level Bombing HA (AP & GP)
Chance of hit per bomb	60%	10%	2%

**Bombing Hit Modifiers**

Target Size modifier - calculate and add  $(BTF - 15)/2$  to the hit probability. Based upon the size of the specific target. If the air base target is behind a smoke screen, the hit probability is halved ( $\times \frac{1}{2}$ ).

The percentage chance to hit of each bomb, after modifiers, is then multiplied by the number of bombs (of the same size) dropped by all the aircraft in the Air Group. The resultant percentage is the Overall Chance to Hit with that size bomb.

Aerial bombing hits may only cause the standard damage points (equivalent to the weight of the bomb) against air bases.

When GP bombs hit an air base their weight in lbs is used as their 'damage points', so a 500lb bomb causes 500 damage points. If AP bombs are used against air bases their effect is 1/3 the damage that would result against a ship. For example a 500lb AP bomb dropped on an airfield would only cause 166 points damage.

Air attacks against air bases can never be Critical Hit. However air operations are affected whenever the airfield damage points are reduced by 25% or over. When 25% damage is caused the LF is reduced by 9/3. For 50% damage LF reduced by 18/6. Aircraft cannot land or take off from an airfield with a LF reduced to 0. A 25% reduction in damage on a sea plane base reduces the LF by 3/3. Air base repair is possible when specialised engineering/repair parties are available. Typically there are two of these engineering/repair parties for any large air base - each 50% chance of being capable of repairing up to 500 points for every hour of work (without air attack or bombardment).

In addition every time 10% damage is caused 20% of the aircraft on or adjacent to the airfield runway (ready or just landed) are also hit. For each roll a D6 - 1,2 destroyed, 3,4 damaged, 5,6 minor damage (requiring 6 hours to repair).

## Ship Damage Control

Fire and flooding damage are categorised as Minor, Major or Serious. Minor fires/flooding causes 100 pts damage when started and for each subsequent turn not brought under control. Major fires/flooding causes 250 pts when started and each subsequent turn. Serious fires/flooding causes 600 pts when started and each subsequent turn.

Heavy naval guns have no limitations wrt the Critical Damage Effects. Medium naval guns (6 to 10-inch) cannot cause serious fires/flooding on battleships (BB) – all such effects are reduced to major fires/flooding. Small naval guns (<5.6-inch) cannot cause serious or major fires/flooding on BB, CA or CL – all such effects are reduced to minor fires/flooding. Torpedo and aerial bombing hits have no such limitations.

Damage control parties (DCP) have a 50% chance (4,5,6 on D6) of stopping fires/flooding each turn. DCP if successful reduce fires/floods by steps – serious to major to minor to stopped (put out). Fires and flooding damage is cumulative for as long as they occur and until they are stopped. So in the best circumstances a damage control party will take at least 3 turns to stop a serious fire/flood. Also warships only have limited numbers of damage control parties onboard:

- 3 DCPs on BB, CVs;
- 2 DCPs on CA, CL, CVL and AVs;
- 1 DCP on DD, DE, PG and most naval auxiliaries
- No DCP on Merchant vessels (unless transferred from naval vessels)

If an aircraft carrier with 3 major fires and 1 major flood has only 3 DCPs and hence must chose which of the 4 fires/floods that will be left alone.

All fires/floods which are not being fought by a DCP are uncontrolled. Each turn there is a 1 in 6 chance (6 on D6) that an uncontrolled fire or flood will escalate, ie. step up – minor to major, or major to serious. Serious fires/flooding cannot step up as they are at the maximum possible.

## SUBMARINE WARFARE

Submarines are characteristically an offensive weapon. On the surface they were operated like torpedo boats moving in close to enemy ships to cause great harm with their powerful torpedoes. Submarines, however, could also submerge – during WWII they were effectively submersible boats. They could become largely invisible to surprise their enemies. A large part of submarine warfare during WWII was conducted at the strategic and operational levels and hence form part of the wargaming scenarios for specific campaigns & naval operations. Much of the Battle of the Atlantic 1939-45, involving sophisticated submarine and anti-submarine warfare, can be simulated at the campaign level. Tactical actions by submarines are always undertaken on an individual boat basis. The following rules are mostly deal with tactical aspects of mine warfare as they affect operations and tactical combat.

Each submarine can operate in four modes: surfaced (fully), awash, periscope depth, and submerged (fully). Submerged submarines operate at periscope depth, normal depth and deep diving depth.

A submarine on the surface (fully buoyant) could move and fire as any other ship using the above rules, although, due to their vulnerability the submarine normally avoided surface gunnery action. Only surfaced submarines are able to fire their guns. Night time torpedo attacks on the surface involved less risks and hence were a favourite submarine tactic. A surfaced submarine may fire its torpedoes using a surface torpedo attack as explained below (equivalent to other surface vessel torpedo attacks). Also ‘surfaced’ submarines would run their diesel propulsion systems to move on the surface, to recharge their batteries and to ventilate the submarine. Surfaced submarines have duty officers and lookouts in the conning tower and may have gun crews or other crew on the casing. They are visible at the distances given previously and repeated below. Submarines do not operate on the surface in sea conditions of Beaufort Scale 7 or over, rather they tended to ride out storms submerged.

The time taken for ‘surfaced’ (fully buoyant) submarines to submerge is 1 minute more than the time to ‘crash dive’ – typically for a Type VII U-boat (60+30) or 90 seconds.

A submarine could run ‘awash’ (low in the water with approximately neutral buoyancy) with its conning tower and a small part of the casing exposed. In this mode submarines could have command and lookouts in the conning tower while they ran the diesels with intake & exhaust valves open. An awash submarine cannot fire its guns. A submarine running awash may fire its torpedoes using a surface torpedo attack as explained below (equivalent to other surface vessel torpedo attacks). The time taken for an ‘awash’ (neutrally buoyant) submarines to

submerge is known as the time to ‘crash dive’ – typically a Type VII U-boat could ‘crash dive’ in 30 seconds. A crash dive involves high speed use of planes, flooding of main ballast tanks & internal fwd tanks (flood Q), and at times most of the crew rushing forward in the boat to trim forward. At the same time the lookouts and watch officers in the conning tower would dive through the conning tower hatch and shut it.

**Submarine Detection Distances from Surface Vessels and Aircraft** (detected as enemy SM)

	Radar/Aircraft (max)	Visible Good (max)	Dark Night (max)
Surfaced or Awash Submarine	12,000yds	6,000yds	800yds
Submarine at Periscope Depth	3,000yds	3,000yds	400yds

Reduced to 50% range for early airborne radar (ASV I/II).

**Target Detection Distances from Surfaced, Awash, or Periscope Depth Submarine**

	Visible Good (max)	Dark Night (max)	Periscope (max)	SM Radar Mast/Periscope
BB, CV & AO	24,000yds	4,000yds	5,000yds	24,000yds / 16,000yds
Destroyers & Patrol Boats	12,000yds	2,000yds	4,000yds	16,000yds / 6,000yds
Large Formation of Aircraft	24,000yds	4,000yds	5,000yds	48,000yds / 16,000yds
Single Aircraft	12,000yds	2,000yds	4,000yds	24,000yds / 6,000yds

Submerged submarines are not visible to radar, aircraft or eyes on or above the surface.

During WWII most submarines had a split periscope capable of searching for aircraft and surface vessels.

Minimum radar detection range is 1,000yds, ie. radar detection is lost below 1,000yds.

The reason submarines travelled awash was to minimise the time it took to dive the submarine below the surface so that it would no longer be subject to observation and potential attacks from ships or aircraft – ie, the submarine would crash dive.

Using the above chart it is possible to determine how long a submarine has to submerge before it can be attacked by a surface vessel or aircraft. For example: in good visibility a British destroyer sees a Type VII U-boat running on the surface at 6,000yds, while the same U-boat sees the DD at 12,000yds. If the DD is at 30kn it will take 6 minutes to reach the point that the SM was first seen. The U-boat crash dives, taking 1 ½ mins, and can then move submerged (at its max. submerged speed) for the rest of its turn. Another example would be if the U-boat and a British Wellington GR Mk XIV aircraft saw each other at 12,000yds. The Wellington travels at 204kn so it would take 53 seconds to reach to U-boats position. The U-boat would be part way through its crash dive and hence still on the surface when the Wellington bombed it. The aerial bombing rules would be used for this attack. If the U-boat was initially awash it could crash dive in 30 seconds and moving at maximum submerged speed (burst speed) away from their sighted position – actual move is 53 seconds at 7.6kn (224yds).

A submarine at periscope depth is considered submerged. It involves the submarine moving approximately 20 to 50 feet below the surface in a position where its periscope(s) could be raised above the water for observation. A submarine using its periscope(s) is limited to a maximum submerged speed of 3 knots, due to the strength of the periscope tube. A submarine at periscope depth, and running up to 3kn, may also fire its torpedoes using a submerged torpedo attack as explained below. A submarine attacking at periscope depth would typically use its periscope continuously for observation at distances over 3000yds from enemy units. Whenever the submarine moved in for a torpedo attack, at 500 to 1000yds, it would use its periscope intermittently, raising and lowering it for a few seconds

only when being used to confirm firing calculations. Such intermittent use of an attack periscope cannot be detected or acted upon by an enemy observer.

Submarines operating beneath the surface at periscope depth have a reduced chance of being detected by visual means, radar, or wireless direction finding (DF). Detection of alternative masts and/or snorkel used at periscope depth are treated with the same chance of detection as a search periscope. Submarines at periscope depth cannot be hit by gunfire or surface/aerial torpedo but they may be rammed by a determined opponent. Submerged submarines may fire torpedoes at another submerged submarine if they are able to range-in on them.

Many submarines, especially later in the war, were equipped with radar sets and masts. Submarines operating on the surface, awash or at periscope depth could use radar to search and identify enemy surface vessels, surfaced submarines, and aircraft. The standard rules for surface actions would then apply. Note the minimum radar detection range is 1000yds for aircraft, surface ships as well as for submarines.

The fourth mode of operation for submarines is to run fully submerged. The submerged submarine is driven deeper using its planes below 50 feet and up to its test depth. For convenience these rules use the terminology 'normal dive' when a fully submerged submarine moves between 51 and 180 feet deep, and 'deep dive' when a submarine moves between 180 feet and its 'test depth'. When a submarine dives below its 'test depth' there is a chance of hull collapse, which increases until the 'crush depth' where it must implode – this is called a 'very deep dive' in these rules.

Crush Depth =  $1.5 \times \text{Test Depth}$  (100% chance of implosion).

Submarines going 'very deep' have a 20% chance of being crushed each time they go below test depth, ie.  $1.0$  to  $1.4 \times \text{Test Depth}$ . The chance increases to 80% for  $1.4$  to  $1.5 \times \text{Test Depth}$ . 'Very deep' is only to be used in emergencies.

Bottoming of submarines was used at times, infrequently, to hide in the surrounding seafloor. It should only be attempted in normal and deep depths. The submarine does a controlled dive using planes at low speed (2kn max.) until it is in position just above the, preferably sandy, surface. The submarine is then trimmed forward toward until the bow touches the seabed. It is a high risk activity.

Submerged submarines aim to minimise the chance of detection and/or wish to avoid depth charge attacks. It is a defensive measure used where these advantages are balanced by the inability of the submarine to observe units on the surface and its inability to fire torpedoes at depth. A submarine that has gone 'deep' is harder to find by surface sonar (50% chance for typical & 10% chance for silent running).

Submarines operating below periscope depth, (ie. at normal, deep, or very deep depths) cannot fire torpedoes.

Submarines operating beneath the surface, (submerged at normal, deep or very deep depths) cannot be detected by visual means or radar from the surface. Underwater detection systems involving hydrophones (passive sonar) and/or ASDIC (active sonar) were used to detect, track and direct anti-submarine attacks on submerged submarines. Game rules for such methods are explained in the Anti-Submarine Warfare section below.

Individual submerged submarines had their own passive and active sonar systems that were used to detect enemy surface vessels and submarines (surface or submerged). Passive sonar or hydrophones were used to listen for underwater noises emitted by enemy surface units or their weapons. Like ears of a submarine, passive sonars listened without being detected. Active sonar (ASDIC) sent out an echo impulse that reflected off of enemy units and returned to the source. Submerged submarines using active sonar would give away their own presence as their opponent would normally hear the ‘buzz’ or ‘ping’ of echo ranging impulse. Single ping ranging was sometimes used to determine underwater ranges. Like someone yelling across a cavern to hear an echo, the submarine using active sonar would be heard.

**Target Observation Distances from Submerged Submarine (Periscope, Normal & Deep Depths)**

	Hydrophone / Passive Sonar	Single Ping Ranging / Active Sonar
Convoy or Fleet Unit	50nm	-
Destroyers & Single Boats	10nm	4000yds

Aircraft cannot be observed using hydrophone or sonar by submerged submarines.

Submerged submarines frequently used ‘silent running’ to minimise detection at depth. Silent running involved moving slowly (up to 3kn) with all non-critical machinery stopped and with the crew avoiding any unnecessary noises.

**Underwater Detection of Silent Running Submarines**

‘Silent running’ submarines cannot be detected by hydrophones or passive sonar.

For ‘silent running’ submarines, active sonar has a 10% chance of detecting a submarine running deep, a 20% chance of detecting one at normal depth, and a 40% chance of detecting a ‘silent’ submarine at periscope depth.

**Submarine Movement and Depth Records**

All movement of submarines on the surface (fully surfaced or awash) is conducted on the gaming table iaw the rules for surface ship movement listed above. Submarine surface speeds are used.

All movement of submerged submarines (at periscope depth, or at normal, deep or very deep depths) is plotted on a Submarine Tactical Movement Plot – consisting

of a sheet of graph paper. The Submarine Tactical Movement Plot has a datum point and two edges marked, normally representing the corner of a table, and has a clear scale. The Plot covers the submerged area beneath the table and will be used when or if necessary to transfer a submarine or torpedo attack onto the table itself. Each submarine has to write down their position, their depth, whether they are using periscopes, masts, torpedoes or active sonar. Each submarine also has to maintain a continuous trace of its movements per turn (3 min). Several submarines may be traced on the same Submarine Tactical Movement Plot however they each operate independently. Turns are conducted in the same manner as surface vessels, in 45 degree increments on the submarine's length. Noting that for a 210ft / 70yd long submarine the turning circle on the table has a diameter of 1.4cm. Submarines are very manoeuvrable.

Submarines operating at periscope depth must use the Submarine Tactical Movement Plot in the same manner as other submerged submarines. The periscope, or other raised mast, is not placed on the table unless they are observed by a surface or aerial enemy unit. When attack periscopes are used intermittently they are not placed on the table surface, rather when observed a spot location is 'detected' as 'periscope seen here' and then disappeared.

For example a British Wellington aircraft equipped with ASV III radar, conducting an anti-submarine patrol on a dark night, detects an awash German submarine at 5nm (10,000yds). The aircraft approaches the submarine until it loses its radar plot at 1000yds. It then switches on its Leigh Light to illuminate the submarine. The submarine sees the aircraft at the same time and range. Now approaching at 150kn the Wellington takes 12 seconds to reach the submarine which it bombs with 4x600lb A/S Bombs. The awash submarine is part way through its 30 second crash dive when hit.

Submarines may employ 'radical manoeuvring' while on the surface however when doing so they cannot dive beneath the surface. A submarine using radical manoeuvring must move at its maximum surface speed. It was better practice to crash dive, run at maximum submerged speed while diving to normal depth, and then using silent running to avoid detection.

### **Changing Submarine Depths**

The maximum change of depth that a diving submarine using its planes can achieve whilst at periscope depth (0 to 50ft) is up to 1½ ft/sec, that is 270ft per 3min turn. Submarines changing depth at normal or deep depths, (below 50ft), can do so at a rate of 2ft/sec, ie. 360ft per 3min turn. For example a submerged submarine moving at 3kn at normal depth, moves 300yds per turn (3 mins) on the Plot and can change depth by up to +/- 360 feet in the same turn.

An alternative method for submarines to change their depth was by changing their buoyancy from neutral to positive or negative. Such changes were called an 'emergency blow' to rapidly rise to the surface, and less frequently 'emergency dive' aimed at rapidly reaching a deep depth. These methods can change the

submarine's depth from deep to surface in one turn or vice-a-versa. Both methods involved considerable risk of overshooting, so for these rules there is a 40% chance of a 1.2 x overshoot on the target depth, and a 10% chance of a 1.5 x overshoot on the target depth. For an 'emergency blow' overshooting the surface by 1.2 leaves the submarine incapable of movement or action for another complete turn, and at the same time means that an enemy within destroyer detection distance automatically sees the submarine broach the surface. A 1.5 overshoot on the surface has the same result except that the submarine loses buoyancy and floods back to periscope depths for the two following turns. In this case all systems are inoperable, including the periscope. At the end of these two turns the submarine may regain control and rise to the surface. Whenever 'emergency dive' is used an overshoot of 1.2 means that the submarine goes down to that depth. The submarine stays at this depth for a turn unable to move or change depth. If this is very deep the submarine will have a change of implosion. A 1.5 overshoot on an emergency dive has a greater chance of implosion, as the submarine continues to dive out of control at the same rate for another turn. If the submarine reaches its 'crush depth' the submarine is lost.

### **Submarine Torpedo Attacks**

Submarine torpedo attacks largely follow the rules set out above for surface combat with torpedoes. Submarines typically have several forward and aft submerged torpedo tubes, which, when fired, may be reloaded with torpedoes. Some submarines also have a number of external torpedo tubes which cannot be reloaded unless in harbour or alongside a depot ship. For maximum effect submarines fired in salvos of 1 to 4 torpedoes. At point-blank range these were direct bow or stern shots, while at short range, 1000yds or over, fan shots were used. Submarine torpedo attacks cannot be undertaken at 300yds or less, day or night, to ensure it has room to arm itself and to avoid damage to the firing submarine. The maximum range for surfaced or submerged submarine is 8000yds. All torpedo attacks have to be at short range or point-blank range.

Submerged submarine torpedo attacks are undertaken only by submarines operating at periscope depth. The submarine was limited to moving straight ahead at no more than 3kn for the move in which the torpedoes are fired. Submerged submarines firing torpedoes at point-blank range are not seen, they also have an improved chance of hitting. Submarines firing torpedoes at longer ranges leave a visible trace – they have to leave a mark on the table at the firing point for up to 2 turns. Tactically point-blank range was preferred.

Surfaced submarine torpedo attacks are undertaken by fully surfaced or awash submarines. When firing forward torpedoes the submarine had to move straight

ahead at between 5kn and 12kn for that turn. Firing aft torpedoes was safer hence the submarine had to move straight ahead at between 5kn and 18kn (more than most submarines were capable of) for that turn. Surfaced submarines firing torpedoes, even though they were fitted with compensating tanks, often found that their bows porpoised as the torpedoes left the tubes, leaving them more susceptible to sightings (use destroyer visibility ranges, ie x 0.5 not x 0.25). Tactically, point-blank range was preferred for surface torpedo attacks as well.

## Submarine Torpedo Damage Points & Ranges

Type	Damage Points	Point-Blank Range	Short Range (max.)
18-inch	600 pts	1000yds @ 40kn	3500yds @ 40kn
21-inch	800 pts	1000yds @ 40kn	8000yds @ 40kn

For point-blank attacks the torpedo runs for less than 45 seconds – so no matches are required.

Torpedo salvos run until they reach the end of their short range run – so the matches need to stay in place.

For 21-inch TT runs this may be up to 2 turns (6 minutes).

## Submarine Torpedo Basic Hit Table & Modifiers

The following table is used to determine the basic percentage chance of submarine torpedo salvo hits. This is the same as that used for surface actions but simplified for submarine torpedo attacks only. The basic hit percentage is then modified for target size and speed.

Torpedoes in Salvo		up to 4000yds	6000yds	8000yds
1	(1 hit)	0-50%	0-10%	0-10%
	(2 hits)	-	- -	
2	(1 hit)	26-55%	6-35%	0-15%
	(2 hits)	0-25%	0-5%	-
3	(1 hit)	31-60%	11-40%	6-20%
	(2 hits)	0-30%	0-10%	0-5%
4	(1 hit)	33-65%	13-45%	8-25%
	(2 hits)	0-32%	0-12%	0-7%
5	(1 hit)	36-70%	16-50%	11-30%
	(2 hits)	0-35%	0-15%	0-10%
6	(1 hit)	36-75%	18-55%	13-35%
	(2 hits)	0-37%	0-17%	0-12%

### Torpedo Hit Modifiers

Target Size modifier – calculate and add  $(STF - 15)/2$  to the hit probability.

Target Speed modifier – calculate and subtract  $(Knots - 15)/2$  from the hit probability.

If the target ship is conducting 'radical manoeuvring, the hit probability is halved ( $\times \frac{1}{2}$ ).

If the target ship is behind a smoke screen, the hit probability is halved ( $\times \frac{1}{2}$ ).

When a homing torpedo is used or a pattern running device is fitted, the torpedo hit probability is doubled ( $\times 2$ ).

Range modifier for submarine 21-inch & 18-inch torpedoes – add 10% to the hit probability for every 1000yds less than 3500yds, (ie. 500yds + 30%, 1500yds +20%, 2500yds +10%). Minimum is 300yds.

Once a torpedo hit results, a D6 is rolled for critical hits. If the hit is not critical the torpedo damage points result. If it is critical the Critical Hits Determination (CDT) table is consulted as discussed previously.

Submarine torpedo fire is limited, typically they carry one reload for TTs limiting their torpedo fire to twice per sortie (or game). Reloading TTs takes 5 turns (15 minutes).

From late 1944, blind torpedo firing was possible for German Type XXI submarines fitted with Nibelung hydrophones and acoustic torpedoes. These submarines may fire at 'detected' targets at ranges up to 4000yds, from the surface, at periscope depth or even at normal depth down to 100ft.

Between 1939-41 the Germans suffered technical problems with their submarine torpedoes causing many to run too deep or to fail on contact – they were duds. It was a 'Torpedokrise'. Torpedo testing before the war did not adequately reflect actual torpedo performance on operations. Internal organisational resistance meant that it was some years before the torpedo defects were rectified. Coincidentally a similar failure of submarine torpedoes occurred with the Americans (Mk 14) between 1941-43, with a parallel resistance and long delay before they were rectified. Such 'dud torpedoes' are not specifically addressed within this rules set, however they will usually be addressed in any related campaign or operation. A 50% failure rate was recorded by the US Navy, although some submarine captains never had a problem while other submariners had all duds.

### **Submarine Surface - Naval Gunfire**

Submarine may fight fully surfaced to fire their surface naval guns and/or anti-aircraft guns against enemy units iaw the general surface action rules presented above. Generally surfaced submarines only attack using surprise gunfire at night, there are times however when a low risk opportunity of presents itself during the day. A surfaced submarine may risk firing at an unarmed merchant vessel during the day, although there was a chance that the merchant was either an armed merchant or a decoy. Surfaced submarines could use surface gunfire to sink a crippled ship when their was little or no danger of attack by other enemy units.

### **Charging Batteries & Snorting**

During WWII submarines were invariable diesel/electric powered. The diesel engines were used on the surface, where they needed to take in air and exhaust to atmosphere, while electric motors supplied by batteries were used when the submarine was submerged. The batteries, in turn, had to be recharged using the diesel engines as generators. For this reason, it is important to keep a record of each submarine's 'Battery Charge Percentage' (BCP) throughout a campaign. The BCP is calculated every hour. It is also often an important determinant for submarine tactical actions.

Battery discharge occurs whenever the submarine is submerged and fully reliant on its batteries. The battery is discharged 80% for every hour a submerged submarine moves at its 'burst speed' (maximum submerged speed). This is often given as maximum submerged speed for 1 hour (at 80% for 1 hour) – Type VIIB U-boat, 8nm in 1 hour at 8kn. Moving at 'cruise speed' the battery discharges 80% of the battery in 20 hours (at 4% per hour) – Type VIIB U-boat, 90nm in 22.5 hrs at 4kn. In 'silent running' the battery discharges at the submarine's minimum rates for hotel load and efficient speed, 80% of the battery in 48 hours (at 1.66% per hour). A submarine in 'emergency stop' mode uses 1% of full battery power every hour until no battery power is left at which time the crew are left to die unless rescued by an outside force. Using these values a running total of the Battery Charge Percentage is maintained for each submarine.

Battery charging occurs when the submarine is on the surface or awash, with the diesels engaged and the air induction valve open. Typically a submarine recharges its main batteries in from 6 to 8 hours. This is simulated in these rules by a simple rule of thumb: For each knot of diesel surface speed (up to 3kn) transferred to the generator, 5% of battery charge is produced each hour. So a submarine running on the surface at its maximum 17kn reduces speed by 3kn to 14kn, can generate 15% (3kn x 5%) of main battery power each hour. The maximum charging capacity on any submarines is 15% per hour (3kn x 5%), noting that the battery charging rates are limited to avoid 'gassing' within the boat. The maximum battery power is 100%, while a submarine would normally not allow its main batteries to go below a 20% reserve.

Example: A Type VIIB U-boat has attacked a convoy, fired torpedoes, crash dived and fled the scene of action for ½ hour – using 40% of its battery. It then remains at silent running for 3 hours – using another 5% of the battery. For the rest of the day, 8½ hours it stays submerged at cruising speed – using 34% of the battery. The battery BCP is now at just 21%, which limits the submarine's tactical options severely, so the submarine's captain decides to run at night on the surface to recharge batteries. The submarine runs awash at 14kn (three below its max.) and charges the batteries at the maximum rate of 15% per hour. The batteries are fully charged in under 5½ hours.

### **Early Submarine Tactics – Wolf Packs**

Much has been written about German U-boats and 'Wolf Pack' tactics, however it is necessary to understand that such Wolf Packs were invariably directed from the Submarine HQ (*BdU* in Germany or France) and essentially involved actions by individual submarines vectored to their target convoys. In the Atlantic whenever a U-boat detected an Allied convoy it took on the role of 'reporter', regularly sending radio communications to *BdU* on convoy size, position, course and speed. *BdU* would then send orders for nearby U-boats to position themselves ahead of the convoy in the most favourable position for either a daytime submerged or a nighttime surfaced torpedo attack. Each U-boat attack was executed by its own captain in the most favourable circumstances as an individual submarine. The

second or third boat arriving at the scene joined the ‘reporter’ as a back-up trailing behind the convoy, to ensure a regular report on the convoy was sent to BdU. When possible the ‘reporter’ would transfer responsibility to one of the other trailing U-boats, proceed at speed on a flank of the convoy to a position ahead of the convoy where it would then conduct a torpedo attack along with the other U-boats called-in.

German U-boat successes were at a peak in late 1942 and early 1943. There were relatively large numbers of U-boats on operation in the Atlantic. Crews were experienced and confident, and the duration of U-boats on station was doubled by using submarine tankers (Type XIV) and supply submarines (Type VIIF). In addition, the German crypto-analysts (B-dienst) had cracked the Allied convoy code. These circumstances were to turn around in mid 1943 and the high level of German U-boat crew confidence was never to be regained.

### **Late War Submarine Innovations**

From late 1944 some German submarines were fitted with ‘Schnorchel’ or snorkel which allowed them to run their diesels under pressure at periscope depth. The snorkel mast would be raised to allow air to be induced into the submarine by the diesels running. The diesel exhaust would then be expelled slightly below the surface against an exhaust back pressure. The British called this process ‘Snorting’. This process enabled submarines at periscope depth to recharge their batteries while remaining submerged. They were mostly invisible to visual or radar sightings and could avoid most aircraft attacks. For these rules snorting masts are considered the same as search periscopes (which were on the surface continuously).

Another late war innovation in submarine technology led by the Germans was the use of fast submerged submarines, such as the German Type XXI which had a maximum submerged speed of 17kn and a ‘silent running’ speed of 6kn along with strengthened periscopes, communications & radar masts, and snorkel. The maximum speed for silent running and submerged torpedo attack should be increased to 6kn for such submarines. Typical Type XXI tactics were to detect the target using radar or sonar while at periscope depth, then go deeper and ran high speed on a collision course at the target. While at normal depth and without using the periscope, the submarine would fix the target using passive and active (echo-ranging) sonar and automatically compute a fire solution. They would fire one or more homing torpedoes and then escape at normal or deep depths. The Allied ASDIC/sonar was ineffective when the A/S vessel travelled over 15kn.

Submarine launched homing torpedoes (T5 Zaunkönig I) were first used by German U-boats in late 1943 and around the same time pattern running devices (such as FAT) were added to German torpedoes. When either of these types are used the calculated chance of a torpedo hit, iaw these rules, is doubled. Initially T5 torpedoes had a risk of self-harm as they were liable to early activation where they would lock-in on the firing submarine. A delayed activation setting soon overcame this defect.

By late 1943 the German noise reduction efforts had made the U-boats significantly safer. In addition they developed a number of acoustic deception devices to protect their U-boats from acoustic homing torpedoes. Chemically produced bubble decoys were emitted from the stern to confuse ASDIC operators. Static and mobile noise makers were fired from the torpedo tubes or a separate submerged projector to confuse active and passive sonar searches. Other improvements included: a *Wanze* radar detector, the *Aphrodite* balloon radar decoy, improved sensitivity on the passive sonar sets, the Fa 330 rotary-wing observation kite, and increased AA armament. Most of these were niche technologies, none of which made a great difference to the outcome of A/S tactical combat.

# ANTI-SUBMARINE WARFARE

As the importance of submarines in naval warfare increased, so did the relative importance of anti-submarine warfare (ASW) – ASW technology, weapons and tactics changed rapidly throughout the first half of the 20th century. One of the most important lessons learnt was that the strategic focus of ASW was centred upon the safe arrival of shipping, people and goods, at their destination, rather than a focus upon sinking enemy submarines. This meant that it was often more important to use communications intercepts, radio direction finding and cryptography to strengthen, reroute or divert a convoy than it was to hunt down and purposely sink a submarine. Large numbers of anti-submarine (A/S) patrol craft and aircraft were employed to force enemy submarines to submerge and to keep them from attacking valuable ships. For instance aircraft, known to carry poor performance A/S weapons, were effective on so-called ‘scare crow’ patrols.

The following rules concentrate on the gaming aspects of ASW. Aspects of the surface combat, air combat and submarine warfare rules, described previously, are also applicable for many ASW actions. Where further details or clarification is thought necessary for ASW they are presented below.

## Anti-Submarine Warfare Detection

The main rules for detection of submarines by A/S vessels and aircraft are detailed above. For convenience the important A/S aspects are repeated here.

Submarine Detection Distances from Surface Vessels and Aircraft (detected as enemy SM)			
	Radar/Aircraft (max)	Visible Good (max)	Dark Night (max)
Surfaced or Awash Submarine	12,000yds	6,000yds	800yds
Submarine at Periscope Depth	3,000yds	3,000yds	400yds

Submerged submarines are not visible to radar, aircraft or eyes on or above the surface.  
During WWII most submarines had a split periscope capable of searching for aircraft and surface vessels.  
Airborne radar is based on ASV III. Reduce to 50% range for early airborne radar (ASV I/II).  
Minimum radar detection range is 1000yds, ie. radar detection is lost below 1000yds.

A submarine at periscope depth is considered submerged. The intermittent use of an attack periscope cannot be detected or acted upon by an enemy observer on the surface or in the air. Submarines operating at periscope depth have a reduced chance of being detected by visual means, or radar. Detection of alternative masts and/or snorkel used at periscope depth are treated with the same chance of detection as a search periscope. Underwater detection systems involving hydrophones (passive sonar) and/or ASDIC (active sonar) are necessary to identify, track and direct attacks on submarines at periscope depth.

## Detection of Submerged Submarines

Submarines operating beneath the surface, (fully submerged at normal, deep or very deep depths), also cannot be detected by visual means or radar from the surface. Hydrophones (passive sonar) and/or ASDIC (active sonar) are necessary to identify, track and direct anti-submarine attacks on submerged submarines.

## Hydrophones

Hydrophones were used to listen to noises made by individual ships and submarines and to determine their characteristics, range and direction. Submerged submarines using hydrophones are limited to silent running at no more than 3kn. Ships and surfaced submarines using hydrophones are limited to a speed not more than 10kn. At times it was possible to analyse the target's propeller frequency spectrum in order to approximate their speed. They could not be used to identify and track a target for combat. Low noise and minimum interference from other sources/targets is key to hydrophone observations.

### Hydrophone Observation Distances (from surface ships & submarines)

	Average Conditions (max)	Quiet Conditions (max)
Submerged Submarine (not silent)	1,000yds	2,000yds
Surface Submarine	2,000yds	4,000yds
Destroyers & PB	4,000yds	8,000yds
BB, CV & Merchants	8,000yds	16,000yds

Quiet conditions are for submerged submarines in silent mode: Beaufort Scale 4 or less. Dead Calm to Gentle.

Average conditions are for ships or surfaced submarines: Beaufort Scale 4 or less. Dead Calm to Gentle.

'Silent running' submarines cannot be detected by hydrophones or passive sonar.

Submerged submarines above are for periscope depth in average conditions and quiet conditions.

Submarines at normal depth have a 50% chance of detection, those at deep depth have a 25% chance.

The British and Americans generally incorporated their passive sonar capabilities within one set along with their active sonars. In effect this meant that passive sonars were used infrequently by A/S vessels as they relied mostly on their active sonar or ASDIC sets. Later in the war some Allied aircraft used small passive sonars (sonobuoys) to detect submarines. The Germans used their passive sonar GHG set for passive ranging however their A/S efforts had a lesser priority than the Allies.

## Active Sonar / ASDIC

During WWII the preferred method for detecting underwater was to use active sonar. Although the US and Britain developed sonar technologies throughout the 1930s, by the start of WWII the British ASDIC set was the most advanced available. Using a range recorder the British were able to use the submarine's course and speed to predict an intersection point for the A/S vessel's depth charge attack. Early War ASDIC was given to the US Navy which quickly turned it into

their own version based on the British design. The characteristics and detection distances for early war ASDIC are set out below.

**Early War (1939-42) ASDIC Detection Distances (from surface ships & submarines)**

*ASDIC Type 128*. British standard. The sonar dome is fixed or retractable under ship's bow.

Anti-submarine vessel is limited to maximum speed 15kn and constant course. Maximum speed 24kn (½ detection).

Single active beam producing an active cone (16 degrees) through the water.

The active beam sweeps continuously or in 5 degree segments. Active beam gives a continuous 'buzz' or 'ping'.

A stop button is used for interrogation of the echo. This is used to detect range and direction of the submarine.

The detection angle is 90 degrees forward (45 degrees each side) of the sonar dome.

Maximum range for Early War ASDIC is 2000yds (50% at 2000yds, 80% at 1000yds). The maximum range is halved (1000yds & 500yds) if the target submarine is end on to the ASDIC beam. ASDIC loses contact 300yds ahead.

No indication of submarine depths possible for Early War ASDIC.

For gaming purposes it may be necessary to prepare a cone template for Early War ASDIC, 2000yds long with a 90 degree sweep angle measured from the point. Radii should also be marked at 1000yds and 300yds. Similar ASDIC templates should be prepared for Late War ASDIC and Japanese ASDIC when they are used in the campaign.

Throughout much of the war the American and German developments in active sonar reflected the British experience. As far as these rules go, the British ASDIC characteristics can be used for their equivalent American (QC sonar for DD & QCD sonar for SM) and German active sonars (S-Anlage) as well. The main difference in these nation's sonar was not technological but rather in the speed at which they were incorporated across the A/S fleet and in the numbers that were available for use. Although the technology changed considerably during the war, many older vessels continued using Early War ASDIC versions until late in the war, mostly due to competing priorities.

Actual war experience led to a number of gradual improvements in active sonar technology and by 1943 new and improved versions of ASDIC and other sets were coming into general use. The fundamentals did not change, but in effect the Late War ASDIC may be simulated as a different underwater detection system. Once again American (QGA sonar) and German versions reflected the British Late War ASDIC, (or to be fair the British may have copied some improvements from the Americans).

**Late War (1943-45) ASDIC Detection Distances (from surface ships & submarines)**

*ASDIC Type 144Q and Type 147 combination*. British standard. The sonar dome is retractable under ship's bow.

Anti-submarine vessel is limited to maximum operating speed 15kn and constant course.

Maximum speed 24kn (½ detection). Three active beams.

One main beam (Type 144) producing an active cone (16 degrees) through the water.

The (Type 144) main active beam sweeps continuously or in 5 degree segments, giving a continuous 'buzz' or 'ping'.

A stop button is used for interrogation of the echo. This is used to detect range and direction of the submarine.

The detection angle is 90 degrees forward (45 degrees each side) of the sonar dome.

The Q set produces a second wedge shape beam, extending up to 1200yds and arcing from surface down at 65 degrees.

The Q beam reduces the dead zone ahead of the A/S vessel to maintain contact with the target for as long as possible.

The Type 147 set produced a third fan shaped beam, extending up to 1000yds range with an arc of 60 degrees. This sonar interrogated the depths for the target submarine and was capable of detecting its actual depth. Maximum range for Late War ASDIC is 2500yds (50% at 2500yds, 80% at 1500yds). The maximum range is halved (1250yds & 750yds) if the target submarine is end on to the ASDIC beam. ASDIC loses contact 100yds ahead.

Other nations, particularly France developed their own ASDIC sets along side the British versions and at times during the 1930s the French may have even lead the technological developments. For the French use British ASDIC data. The Italians, on the other hand, ignored sonar/ASDIC developments until the early 1930s. For the early war period the Italians should also use British ASDIC data. The Japanese also neglected anti-submarine warfare compared with the Allies, although they did have about 50 low-performance (Type 93 passive/active sonar) sets by December 1941. This low priority did not change throughout the Pacific War, even when the Japanese had disastrous losses due to USN submarine operations, so Japanese ASDIC characteristics apply from 1939-1945. ASDIC characteristics and detection capabilities for the Japanese are presented below.

#### **Japanese (1939-45) ASDIC Detection Distances (from surface ships & submarines)**

*ASDIC* Japanese Type 93 (Mod 3) standard. The sonar dome is fixed or retractable under ship's bow.

Anti-submarine vessel is limited to operating speed 12kn and constant course, due to interference.

Maximum speed 20kn (½ detection). Single active beam producing an active cone (16 degrees) through the water.

The active beam sweeps continuously or in 5 degree segments. Active beam gives a continuous 'buzz' or 'ping'.

A stop button is used for interrogation of the echo. This is used to detect range and direction of the submarine.

The detection angle is 90 degrees forward (45 degrees each side) of the sonar dome.

Maximum range for Japanese ASDIC is 1200yds (50% at 1200yds, 80% at 600yds). The maximum range is halved (500yds & lost) if the target submarine is end on to the ASDIC beam. ASDIC loses contact 300yds ahead.

No indication of submarine depths possible for Japanese ASDIC.

To be accurate in late 1944 the Japanese did introduce their Type 3 sonar which was based on the Late War German S-Gerät active/passive sonar. However the introduction of the Type 3 was slow due to manufacturing delays and the rapid reduction in the number of available A/S escorts. Some Japanese escorts may use Late War ASDIC detection data iaw these rules to simulate their use of Type 3 sets.

The above ASDIC detection ranges and percentage chance of contact, including modifiers for submarines running deep and for silent running, are summarised below:

#### **ASDIC Chance of Contact at Detection Ranges (from A/S Vessels)**

	Submarine	Deep SM	Range	Silent Per' SM	Silent Norm. SM	Silent Deep SM
Early War ASDIC	50%	25%	2000yds	40%	20%	10%
	80%	40%	1000yds	64%	32%	16%
	lost	-	300yds			
Late War ASDIC	50%	25%	2500yds	40%	20%	10%
	80%	80%	1500yds	64%	32%	16%
	lost	-	100yds			
Japanese ASDIC	50%	25%	1200yds	40%	20%	10%
	80%	40%	600yds	64%	32%	16%
	lost	-	300yds			

Submarines move under the surface mainly to minimise the chance of detection and to avoid depth charge attacks. A submarine that has gone 'deep' is harder to find by ASDIC, for these rules the percentage chance is halved for a typical submarine. Submerged submarines in 'silent running' mode can also minimise detection by ASDIC. For 'silent running' submarines, active sonar, at maximum range, has a 10% chance of detecting a submarine running deep, a 20% chance of detecting one at normal depth, and a 40% chance of detecting a 'silent' submarine at periscope depth.

### **Magnetic Anomaly Detection (MAD)**

The changes to the earth's magnetic field caused by a submerged submarine were towed behind some A/S vessels and later, when the equipment was much smaller, in aircraft. Detection of a recently dived or periscope depth submarine was possible, by using MAD with a slant range of 500yds (80%). Detection would then be confirmed (100%) when the ship travelled over the target. MAD arrays were able to detect submarines up to 50ft deep (periscope depth). A Japanese version of MAD (*Jikitanchiki*) was used by escorts alongside the poor performance Japanese ASDIC. This version may be used in these rules, using an 80% chance of detecting a submarine at 500yds and a 100% chance of detection as the ship proceeds over the submarine. The ship would have to return to the position to drop depth charges.

### **Attacks on Surfaced Submarines**

By 1939, when a surfaced submarine (fully surfaced or awash) was detected it could be attacked by surface ships (or other submarines) using gunfire, torpedoes, or ramming. Alternatively it could be attacked by aircraft using A/S bombs, torpedoes, strafing, rockets, or airborne depth charges. Often the most successful attacks on a surfaced submarine involved a combination of A/S ships and aircraft. In these circumstances the same rules that apply for observation, surface action and air attack, outlined above, are used. Note that a submarine is vulnerable on the surface. It was a relatively small target, not capable of high surface speed, and had little strength (ie. has few defensive points). For these reasons submarines tended to only conduct surface attacks at night when they could use darkness to avoid detection and where they could undertake a surprise surface torpedo attack.

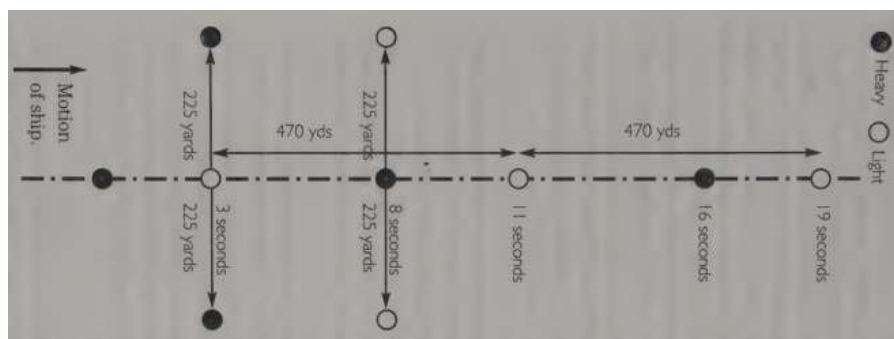
### **Attacks on Submerged Submarines**

Submerged submarines (travelling at periscope depth, normal depth, deep depth or very deep depth) can only be detected by sonar. Once detected the submarine can only be attacked by an enemy using underwater weapons, such as the depth charge. A submarine at periscope depth may be detected from the surface or above because it is using a periscope or mast but surface or aerial weapons (gunfire, torpedoes, bombs and/or ramming) will have no effect on the submarine.

A submarine at periscope depth, like all submerged submarines, can only be attacked by an enemy using underwater weapons, such as the depth charge. Submarines at periscope depth cannot be rammed, even when exposing their periscopes or another mast, as they would rapidly lower the mast before the vessel attempting to ram can approach.

### Depth Charge Attacks

Depth charge attacks occur at the end of each firing turn, at the same time as torpedo attacks. The A/S vessel attacking cannot use ASDIC or drop depth charges accurately unless maintaining course and speed - not faster than 15kn. In most cases ASDIC contact is lost 300yds ahead of the DC position, the vessel moves over the submarine, and then the DCs are deployed at a safe distance to the rear of the vessel (at least 30yds). Each A/S vessel firing DCs places markers for each depth charge on the table (with pins or a template), forming the depth charge pattern. The pattern is produced using the actual characteristics of the A/S vessel. Each DC rack and/or chute was capable of dropping one DC every 40yds (~5 sec apart), while each DC thrower could fire one DC at a distance of 40ft, 50ft or 70ft. The depth setting for each DC must also be recorded on the depth charge pattern. Note standard depth charge patterns, such as the double diamond pattern, were used throughout the war. For example the RN started using 5 DC patterns, which were replaced by 14, then 10 and 26 DC patterns, in an effort to swamp any target submarine. DC outfits on A/S Escorts increased from 15-40 DC to 60-160 DC throughout the war. Escorts can only launch one DC attack each turn (3 min), they would need to spend the remainder of the turn reloading the DC racks, chutes and throwers.



*Typical British 10 Depth Charge Pattern, 1943-45 (19 seconds launch, area covered 940ft x 450ft)*

Ahead throwing depth charge projectors first came into service in late 1942 however they were generally unreliable until improved versions and experienced

crews started using them in 1944. They were intended to remove the detection blind spot between ASDIC minimum range ahead of the A/S vessel and dropping depth charges over the vessel's stern. The Hedgehog and the Squid depth charge throwers were the standard forward firing versions used by the Allies.

Hedgehog depth charge throwers fired 24 DC projectiles to a position 200yds ahead of the A/S vessel. The speed of advance for the A/S vessel was set at 8 to 10kn. The DC projectiles landed in a pattern forming a circle of 40yds diameter, with each projectile sinking rapidly to a set depth. Each DC projectile weighed 65lb (oa) and had a charge of 35lb (damage 105/35 pts each). Projectiles were triggered by contact fuzes and hence did not require depth settings. Hedgehog projectiles had a maximum effective depth of 400ft. Standard depth charge rules apply for the use of hedgehog systems – the depth charge pattern is set and although each DC projectile may have a relatively high chance of hitting when cf. DCs, the damage caused is relatively small.

Squid depth charge throwers were introduced in late 1943 but were not common until mid 1944. They had three barrels each capable of firing a 390lb (oa) DC containing a 207lb charge (damage 621/207pts each) to a distance of 275yds ahead of the A/S vessel. When fired the three DCs formed a triangular depth charge pattern with 40yds each side. For maximum effectiveness the majority of ships were fitted with 2 Squid throwers (capable of a 6xDC pattern), although some smaller vessels did use single squid throwers. Standard depth charge rules apply for the use of squid systems.

A/S aircraft could also carry out depth charge attacks against known submerged submarine positions. For most of the war this meant the aircraft witnessed the target submarine crash dive and decided to make a low altitude bombing run to drop depth charges effectively guessing the submarines actual position and depth. Such attacks were mostly unsuccessful although they did help to keep the target submarine submerged for longer periods. Aircraft wishing to attack such a submarine place a depth charge pattern, with depth settings, on the table and the results are evaluated iaw the standard surface ship depth charging procedures. Data for aerial anti-submarine weapons, bombs, depth charges and A/S torpedoes is available in the accompanying Data Tables.

Magnetic Anomaly Detection (MAD) was first used by an Allied aircraft, a USN Catalina (PBY-5), in 1943. The changes to the earth's magnetic field caused by a submerged submarine were detected by an aircraft overhead. Detection of a recently dived or periscope depth submarine was possible, by an aircraft at a height of 600ft, with a slant range of 500yds (80%). Detection would then be confirmed

(100%) when the aircraft overflew the target, up to a depth of 50 feet (periscope depth). The aircraft would then drop a pattern of retro-bombs over the target submarine. There were 24 contact fuzed retro-bombs each with 35lb explosive charges. These acted like DC projectiles fired by a Hedgehog even though they were dropped from a low flying aircraft. Note the retro-bombs were propelled backwards out of the aircraft by rockets to counter its forward motion. Some US Navy Airships also used MAD in an effort to detect submarines transiting the Gibraltar Strait during 1944-45.

From 1943, selected Allied A/S aircraft were able to deploy directional sonobuoys (AN/CRT-4). These were small disposable floating passive sonar units were capable of detecting submerged submarines and transmitting a signal back to the aircraft to help set up a depth charge or A/S acoustic torpedo attack. Sonobuoys were used in patterns, typically 5 buoys were dropped to form a sonar search pattern (1 centre, and 4 in corners of a 2nm box). Each sonar buoy had a hydrophone that rotated 360 degrees ever 12 to 20 minutes, and could detect submerged submarines down to 900ft. Radio reception distances were limited to 5nm. The hydrophone ranging distances applied – 1000yds for submerged submarines at periscope depth in average conditions and 2000yds in quiet conditions. Submarines at normal depth have a 50% chance of detection by hydrophones, while those at deep depth have a 25% chance.

### **Depth Charges - Chance to Hit Submarine**

When determining whether a DC hits the depth charge pattern is placed on the table. With the attacker out of the room, the submarine's player transfers the DC pattern to their Submarine Tactical Movement Plot. A careful check is made between the position of the submarine and the depth charge pattern. All DCs dropped overhead or within 20yds of the submarine are hits. Each of these DCs hits is checked for depth setting (in feet) against the submarine's current depth (in feet). If the difference in depths is more than 60 feet they are ignored. A D6 is then rolled for each DC hit. A 1,2 is a critical hit with 3 x damage pts lost & consult the Critical Hit Table for damage. A 3,4 roll is a nearby explosion causing standard DC damage points to the submarine and forcing the submarine to surface by emergency blow and to remain on the surface for at least 1 turn. A 5,6 roll is a nearby explosion causing standard DC damage points to the submarine and with the submarine able to continue operations.

To determine actual submarine position and depth charge pattern it may be necessary to divide the 3 min turn into several segments – say the time ASDIC loses SM (300yds ahead), then to time depth charges are deployed and explode underwater (calculating hits as required), remainder of the move for A/S vessel and

submarine. Subdividing the 3 min turn would also be beneficial for simulating A/S attacks from the air.

Reloading the depth charge racks and throwers would take 3 minutes each when undertaken by experienced 'DC crews'. The average A/S escort in combat would have 2 off crews and hence would take 6 minutes to reload 4 DCR/DCTs, or 12 minutes for 8 DCR/DCTs.

### **Anti-Submarine Homing Torpedoes**

Airborne homing torpedoes capable of hitting submerged submarines at depth were introduced by the Allies at the end of 1942. The effectiveness of an airborne depth charge to sink a U-boat was 9.5% compared with the Mk 24 with a 22% success rate – three times as effective. Figures for 1943-45 reveal a total of 346 Mk 24 torpedoes were launched resulting in 68 submarines sunk and 33 damaged. Airborne homing torpedoes were designed to hit submarines that had just dived, that were at periscope depth, or snorkelling. They were largely ineffective against any submarine at depth (normal or deep) as well as fast submarines (German Type XXII). The Mk 24 Fido 19-inch torpedo is included in the general torpedo attack rules above.

In early 1945 the Japanese tried dropping A/S torpedoes from aircraft. Known as the QR spiralling torpedo, it was a standard Type 91 Mod 2 torpedo (with 320lb charge) arranged to descend in a spiral about 300yds diameter to a depth of 320ft. The torpedo's distance run was 4000yds at 25kn. The aircraft dropped the QR torpedo just over 200yds ahead of the target and hoped for the best – as the torpedo was fitted with a contact fuze. Such torpedoes use the standard torpedo fire methods iaw these rules and have no x2 'homing' advantage.

### **Anti-Submarine Weapon Data**

Data for each Nation's major Anti-Submarine Weapons may be found in the accompanying Data Tables.

*Examples: Allied Anti-Submarine Weapons*

*Mk VII Depth-Charge:* 1939-45, Weight (oa) 420lb. 290lb explosive charge (870/290 damage points). Hydrostatic pistons set from 30 to 300ft deep. (Settings – safe/30/50/75/100/150/200/250/300ft).

*US Mk 24 'Fido':* 19-inch torpedo with a passive acoustic homing capacity and a contact fuze. They weighed 680lb (oa) with a charge of 92lb (damage 300/100 pts). Range was 4000yds at 12kn. Aircraft delivery was at speed of 125kn and height of 250ft.

### **Direction Finding (DF)**

Whenever a submarine used its wireless set for communication it could potentially be analysed by a specialist DF unit so that the direction of the submarine would be known. When two or more DF units received transmissions at the same time the DF results could be triangulated to plot the exact position of the submarine. DFing was particularly useful at the campaign and operational level, as convoys could be rerouted or diverted to avoid known enemy submarine concentrations. In addition, defensive and offensive A/S ships could be concentrated in known submarine hot spots. During the first years of the war, 1939-41, British only used land-based DF units for ASW. Between 1942 and 1944 most A/S escorts were equipped with small DFing sets known as HF/DF (Huff Duff). This enabled DF triangulation to occur at sea and at relatively close distances. Some A/S vessels were able to use HF/DF to run down the direction to rapidly attack enemy submarines.

### **Early War Anti-Submarine Tactics (British 1939-42)**

It is beneficial to provide some background on ASW tactics. In the early part of the war British destroyers used basic anti-submarine search patterns where each A/S vessel operated line abreast in echelon formation, with each 1600 to 2400yds apart. This ensured that their ASDIC scans would overlap sufficiently to efficiently cover a particular channel. Like channels swept of mines, such A/S channels were then used by fleet units, convoys and other high value targets to avoid attack by submarine. Even though very few of these sweeps actually led to a submarine kill, they did ensure that nearby submarines remained submerged (and hence unable to attack) for considerable periods. The British also operated in A/S groups to improve their effectiveness when they engage a detected submarine. One of two vessels, having detected the enemy submarine using ASDIC, would try and maintain the contact for as long as possible. To avoid the blind spot that occurred if the detecting vessel conducted the depth charge attack itself, a third vessel (typically faster) would be the designated 'pouncer'. It would receive wireless communications from the 'detectors' and using the data provided race down and 'pounce' upon the submarine with a DC attack. Such methods and many more were simple but effective.

Anti-submarine aircraft also performed a similar function by flying ASW patrols over particular channels, shipping routes and areas of concentrated shipping. The potential of air attack convinced many submarine commanders to stay submerged for longer. For example when a fast commercial vessel travelled unescorted outside the convoy system it relied upon secrecy of its movements, surprise and speed to avoid submarine attack. It was often difficult for even a submarine on the surface to move to a useful firing position while the ship sped past. There were times however when a submarine found itself in a position by accident where it

could fire at such a valuable target. To avoid such accidental circumstances, A/S aircraft often flew above and up to 40km ahead of the fast commercial vessel, and this effectively forced nearby submarines to submerge well before they were in a position to attack. The US Navy used a similar tactic during 1941 & 1942 whenever they moved their high value aircraft carriers (CV) across the Pacific. Every morning a Dauntless aircraft was launched from the CV on an A/S mission. This aircraft was responsible to protecting the CV and associated fleet from Japanese submarines by flying ASW patrols ahead and adjacent to the route. Most of the time any enemy submarine in the vicinity of the aircraft would submerge to avoid being depth charged by the Dauntless. It also meant that a number of valuable aircraft were not available to the CV flight commander for other actions, as well as inevitably led to some losses due to aircraft accidents.

Perhaps the most intriguing measure relating to ASW during the early war period was the introduction of close range A/S aircraft support for convoys crossing the mid-Atlantic gap. This area was many nautical miles outside the effective range of most A/S land-based aircraft, so a number of merchant vessels were rapidly converted into merchant aircraft carriers (CAM) and escort aircraft carriers (CVE). The availability of aircraft at sea helped protect convoys from the U-boat. CVEs became common place during the later war period, in the Pacific as well as the Atlantic.

In 1939 A/S aircraft relied upon visual sightings of surfaced submarines and periscopes. Airborne surface search radar (ASV I/II) was introduced operationally into RAF Coastal Command aircraft at the end of 1940, and soon aircraft were able to operationally detect a surface submarine at ranges up to 3nm (6000yds). The radar would lose objects closer than 1000yds. The German introduced the *Metox* radar detector to warn their U-boats of approaching ASV I/II equipped aircraft. The blind spot covering the 1000yds before the aircraft could overfly the enemy submarine and drop its bombs or depth charges, reduced the chances of hitting a submarine.

Submarines were often one of the most effective ASW measures, as an alert, manoeuvrable submarine crew could dive and position themselves in a good torpedo fire position before an enemy submarine could know they were in the vicinity. One submarine would then use surprise to attack and sink the enemy submarine.

Wireless direction finding, signals analysis and crypto-analysis became increasingly important for ASW during the Battle of the Atlantic from the very beginning of the war. Their importance was confirmed by the British during WWII

and as a result such methods were given a high priority during WWII. Wireless direction finding was used to locate operational U-boats so that major convoys could be rerouted or postponed. By 1942, as discussed below, DFing could be conducted by ships at sea in order to detect and engage U-boats tactically. Signals analysis involved assessment of the volume, processing and flow of enemy signal communications. Strategic information could be obtained, such as command structures, individual U-boat signal traffic, and availability of U-boats in an operational area. Crypto-analysis involved the actual decoding and translation of enemy signal transmissions. Significant effort was given to this activity which did have a major impact strategically. By 1941 the British cryptologists, at Bletchley Park, were at times able to read U-boat signals before their intended U-boat captain received them. Such methods are however largely outside the scope of this naval tactical rule set.

Early detection of submarines was not always achievable and the risks of a successful submarine attack at night remained quite high. From late 1942 escort tactics were revised in a coordinated way often following advice from RN's Western Approaches Tactical Unit (WATU), mostly by WRANS conducting naval war games. Standard tactics like the 'Raspberry' helped to reduce the U-boat success rate against convoys. Of course merchant vessels were still sunk and their crews had to be rescued. Wargaming demonstrated that a designated rescue boat had just 15 minutes (5 turns) to recover survivors before it had to depart at speed to rejoin the convoy. Its inability to return as convoy escort would endanger the rest of the convoy. There were quite a few tactical procedures, including the 'Artichoke', 'Porcupine', 'Observant', 'Banana', & 'Pineapple', which were tested in action, promulgated in the *Western Approaches Convoy Instructions*, and practised in training exercises. In response to the German's use of homing torpedoes the RN escorts either slowed right down or when possible sped up. Baiting tactics and creeping barrage attacks, with three or more escorts, became more common.

As the war progressed ASW detection systems and weapons dramatically increased in their sophistication and in their capabilities. The submarines improved becoming more silent, capable of diving to greater depths and staying submerged longer. During 1944-45 snorkel was introduced and fast underwater speeds achieved by German operational submarines. Both radar and sonar systems improved significantly, although their fundamentals did not change.

### **Late War Anti-Submarine Tactics (Allies 1943-45)**

The most critical advances in the Allied ASW effort during 1943-45 did not follow from technological breakthrough, rather they were the consequence of Allied mass production, detailed cooperation between Allied, Coalition and Combined forces at all levels, and the dramatic increase in the number of escort vessels, escort carriers, A/S aircraft, and A/S weapons. The Royal Navy and the US Navy commissioned large numbers of destroyer escorts, corvettes and sloops, purpose built to protect shipping from enemy submarines. Such vessel and aircraft numbers were instrumental in shutting down much of the German U-boat threat. Although technology did evolve, the fundamentals of a convoy escort using ASDIC to hunt a submarine and depth charges to try and sink it, remained a basic requirement for ASW. Indeed, in the remote sections of the oceans, early war ASW equipment was never upgraded and had to be used throughout the war.

Cooperation between surface vessels, aircraft, and land based units of various nationalities and various armed forces during these years remains an excellent example of best ASW practice. The operational and tactical employment of anti-submarine weapons was intensively studied by both US and British Operational Research Groups, the first of their kind, and by 1943 their work had resulted in manuals of standard practices and tactical procedures that achieved the most out of the weapons available. The Allied Operations Research personnel also identified technological gaps in the tactical employment of the weapons that were subsequently given priority for further development. The Germans did not have an equivalent group.

The Allies managed to turn the tide of the Battle of the Atlantic in 1943 by allocating a single commander (Admiral Max Horton) to win the battle, Horton convinced his RAF colleagues to allocate sufficient numbers of land based long range (LR) or very long range (VLR) aircraft to close the Atlantic Gap, and experienced hunter-killer groups were established. The tactics of the hunter-killer groups were now much more successful. Huff Duff was used to pin-point U-boat locations. Aircraft would confirm their presence and attack, if not hitting the submarine at least forcing then down and keeping then in the area. Fast escorts would then race to the location using radar to scan the area for contacts and surprise any U-boat on the surface. Other escorts would use ASDIC to detect the submarine and maintain an underwater contact. Depth charge attacks would follow slowly but determinedly, detection of the submerged submarine would lead to an extensive depth charge pattern (up to 26 depth charges per pattern). Persistence was then key – the submarine could lay silently for hours but when it did move, the escort had to accurately determine its position, depth and speed, then proceed with an overwhelming depth charge attack. At times intermittent depth charge attacks

continued for up to 48 hours. At that stage a submerged submarine would be close to its endurance limit and its captain would either have to rise to the surface or let the crew rest forever at the bottom of the sea.

From mid 1943 it was possible to add an escort carrier to the hunter-killer groups, (typically consisting of 1xCVE & 4-6 DD/DE). These groups operated as described above but were capable of continuous aircraft support from Avenger torpedo bombers flown from the CVE. The Avenger would be vectored in the direction of the submarine contact (HF/DF) and if spotting a submarine diving or at periscope depth it would launch a Fido torpedo.

Also by 1944 US Navy anti-submarine blimps were making an appearance over chock/focal points. The blimps were capable of almost 2000nm at 52kn with an endurance of over 38 hours. The blimps maximum speed was 70kn, but they had limited armament 1xHMG and 4xDC. The blimps main usefulness was apparently to seagoing morale, as their appearance gave confidence that the waters were submarine free.

In late 1942, German U-boat successes increased due to several tactical innovations. Type XIV submarine tankers were increasingly available to refuel, rearm and resupply U-boats in their operational areas. By this means the length of U-boat patrols was effectively doubled. Not between 1939 and 1942, the German Navy requisitioned merchant supply ships, often under false flags, to replenish armed raiders (cruisers as well as armed merchants) and wherever possible distant U-boats. Such ships were subject to detection and sinking or capture. The second reason for German U-boat successes, in late 1942, followed their crypto-analysis unit's (B-dienst) deciphering of the Allied convoy code. As with the earlier British ULTRA decrypts the German decrypts were used to strategically deploy U-boats across the Atlantic. At the same time the German Navy changed their own codes and upgraded their Enigma machines causing a temporary gap in Bletchley Park's crypto-analysis capabilities.

From 1943, German submarines increasingly used acoustic homing torpedoes (T5 Zaunkönig I or 'Gnat' torpedo) fitted with pattern running devices (FAT – *Federapparat*, or LUT – *Lageunabhängiger* torpedo fittings) which doubled the chance of hitting a target. Using FAT a torpedo would initially run straight in an attempt to hit the target, then change course 120 degrees and run for another 1500yds in a second attempt to hit the target, and continue reversing course in a zigzag pattern alongside the target until the torpedo's maximum range was reached. Alternative torpedo running devices produced spirals and figure-of-eight patterns. German G5 homing torpedoes were initially very effective against A/S escorts

running at speeds between 10 & 18kn. They had a range of 6200yds at 25kn with a homing distance of 500yds. The Allies developed a 'noise maker' (Foxer) that was towed behind an escort as a decoy, that countered the torpedo's acoustic homing device. Note, in these rules homing torpedoes vs escorts with Foxer cancel each other out (ie. no x2 to hit). The Germans also developed a homing torpedo that could be fired at depths down to 165ft (T11 Zaunkönig II), move faster than its predecessor (T5) and home in on specific escorts propeller noise. Perhaps fortunately for the Allies the T11 Homing Torpedo did not become operational during the war.

Allied A/S escort vessels became much more common and there were few, if any, unescorted convoys or merchant ships sailing independently. Each A/S vessel also was more powerful using the Late War ASDIC sets (such as British ASDIC combination Types 144Q & 147). For example although it may not seem critical, the introduction of Q sonar enabled the ASDIC controller to determine the enemy submarine depth fairly accurately and using the automatic fire controller associated with the set, the most appropriate depth charge pattern (with position, depth and speed) was established. In fact this made the standard stern depth charge attack much more efficient – statistics suggest at least twice as many submarines were hit than when using Early War ASDIC (Type 128). In these rules such advantages are not automatic but left to the player to use the full detection information and weapons available.

During 1943 Allied airborne radar also went through a major technological advance. The chance of hitting a submarine starting its dive or at periscope depth increased dramatically with the introduction of ASV III radar and the *Leigh Light* in March 1943. The aircraft attacked at night. The ASV III, running on a 10 centimetre band, and operationally capable of detecting a surfaced submarine at 6nm (12,000yds), was much harder to detect. U-boats were unable to detect the airborne radar's presence. At 1000yds the aircraft would switch on its Leigh Light, a massive spot light run from airborne generators, that illuminated the submarine until the drop zone was reached. The Germans did develop the *Naxos* detector specifically for centimetric radar but it was limited technically and not an operational success.

While the Allies were advancing their airborne radar equipment technology, the Japanese continued to rely upon visual sightings. Late in 1942 they did introduce the Type 64 radar, which was essentially a copy of the British ASV II (and is treated as such within these rules), even then the Japanese continued to rely upon visual sightings by day and tended to use their radar mostly at night. The Japanese did also use airborne MAD (*jikitanchiki*) alongside airborne radar to achieve a few successful submarine attacks.

Japanese submarine priorities remained tactical support of naval and military operations, and whereas they did achieve a few successes in 1942 against high value targets, this policy ultimately led to the failure of Japan's submarine effort. By stalking and attacking Allied warships, the Japanese ensured that their submarines were opposed by the most advanced and dangerous ASW elements.

Overall the Japanese ASW efforts were far too little too late. The number of escorts was greatly increased but there were never enough and the technology was improved but never caught up with the rapid advances undertaken by the British and US Navy which both had extensive Atlantic experience. In relatively simple areas such as ASW command, air-sea communications, and escort tactics, the Japanese never really approached the skill levels of the Allies in ASW. By the end of the war, the Americans had lost 20 submarines to Japanese surface ASW and a further 4 or 5 to Japanese aerial ASW, however this was a relatively small cost to pay for the US Navy's submarine campaign in the Pacific, which in turn sank 1113 Japanese merchant ships of almost 4.78 million tons – over 52% of the total number of Japanese merchant vessels lost in the war.

## NAVAL MINE WARFARE

Naval mines were one of the most effective means of attacking ships during WWII. Unfortunately mine warfare is relatively hard to simulate in a war game. Mine warfare activities run parallel to other surface, air and underwater actions within a naval campaign. These rules are mostly deal with tactical aspects of mine warfare as they affect operations and tactical combat.

Various different types of naval mines were used during WWII. Moored and floating mines which were initiated by contact were the main type at the start of WWII. Such mines were deployed with sinkers and cables such that the mine itself would not be seen floating just beneath the surface of the water. Once deployed tidal effects and weather varied the actual depth settings for these floating mines. Within months the Germans started using magnetic mines, grounded (seabed) mines initiated by magnetic influence, to great effect. Note grounded mines had to be laid in shallow or tidal waters. The British first used airborne magnetic mines in April 1940, acoustic mines in July 1942, and combined magnetic/acoustic mines in April 1943. Airborne mines had to be dropped from low altitude until late 1944 when parachute mines became available capable of being laid up to heights of 15,000 feet. Grounded mines with ship counters and arming clocks were also introduced during WWII. Moored mines were also modified, by 1945, to be set at depths down to 300 feet as anti-submarine mines. Controlled minefields, fired by cable from above ground observers or by underwater signal such as from an indicator loop, were also used extensively throughout WWII for harbour protection.

Defensive minefields are generally laid in one's own or adjacent waters to delay or deny enemy ship movements. They could help to protect ports, beaches or shipping routes and typically included controlled minefields, extensive minefields and mine barrages. They were intended to be long-lasting and their location was known to all friendly forces. Offensive minefields were laid in enemy waters to target specific shipping. These included areas off enemy harbours, across shipping route chock/focal points (ie. Dardanelles), and in areas of high volume ship movements.

Surface vessels were generally used for defensive minelaying as they could lay all types of mines. Some fast minelayers were capable of laying offensive minefields in enemy territory. Aircraft and submarines were used to lay offensive minefields, using mostly seabed mines. Offensive minefields were laid in minelines (with 1 to 8 mine lines consisting of 5 to 300 mines extending over several nautical miles) generally forming a small minefield. There was a risk of hitting a mine whenever a vessel entered an offensive minefield. Defensive minefields or mine barrages

consisted of extensive areas covered with numerous minelines. Transiting through or across such defensive minefields would involve a significant risk of hitting a mine over an extended period of time. The declared existence of a defensive minefield itself prevented vessels from entering the area (even if it was a dummy minefield).

Naval Mines Hits

For a campaign or operation all minefields are to be marked on a map and details given of offensive/defensive, type(s) of mine, number of mines & minelines laid, overall length/area (nautical miles) of minefield, as well as the date it was laid. Whenever a ship or submarine transits an offensive minefield there is a chance it will hit a mine. The chance of a vessel hitting a mine is calculated depending on the number of mines in the minefield.

For a vessel moving through an **offensive minefield**, roll percentage die for that turn to determine whether hit by mine. Adjust the percentage required to hit by the modifiers below. Note linear density of minefield dominates. (Calculate 5% change of hit for every 10 mines in field, rounded down. Transit distance < 2000yds or 1nm)

No. of Mines	5	10	20	40	50	100	150	200
% of Hit	2%	5%	10%	20%	25%	50%	75%	100%
Modifiers:	x2 if magnetic or acoustic influence mines (not if vessel is degaussed) Vessels with paravanes deployed do not hit floating mines but the paravane may be damaged Vessels using mine avoidance radar -10% (ie. can avoid up to 20 mines) Degaussed vessels do not activate magnetic mines							

If a vessel enters a defensive minefield there is a high probability that it will hit a mine (unless of course it is a dummy minefield in which case it is a roll and a miss). The chance of a vessel hitting a mine is calculated depending upon the vessel’s speed and the distance traversed.

For a vessel moving through a **defensive minefield**, roll percentage die for that turn to determine whether hit by mine. (Basic chance to hit for vessel at 20kn travels at 1nm per turn (3 min) through a minefield with 60 mines/nm is 30%)

Calculate: 1.5 x vessel’s speed (kn) = % chance to hit mine.

No modifiers as only moored contact mines are used for **defensive minefields** during WWII, and avoidance using paravanes or mine avoidance radar is not possible as the vessels are not free to manoeuvre effectively.  
Example: Light cruiser at 32kn transits through defensive minefield has 48% chance of hitting a mine each turn, (Note in 3 mins the CL moves 1.6nm through the defensive minefield)

If a vessel enters a harbour which is protected by a controlled minefield there is a chance that it be hit by a controlled mine. The chance of a mine hit on the vessel is calculated depending upon the number of mines in the controlled minefield and the alertness of the shore based observers and the guard indicator loop performance. Automatic activation by indicator, if used, uses the same percentage as an alert crew of observers.

For a vessel moving through a **controlled minefield**, roll percentage die for that turn to determine whether hit by mine. Adjust the percentage required to hit by the modifiers below. Note observer & indicator performance dominates.

Roll for Alertness (percentage):

1-20%	crew dozing no sightings.
21-50%	crew notices indicator movement and asks patrol vessel to investigate.
51-100%	crew fully alert, detonates mines when vessel transits.

Then calculate 5% change of hit for every 10 mines in field, rounded down. Transit distance < 2000yds or 1nm.

No. of Mines	5	10	20	40	50	100	150	200
% of Hit	2%	5%	10%	20%	25%	50%	75%	100%

Modifiers: x2 if magnetic or acoustic influence mines (not if vessel is degaussed).

## Typical Naval Mine Characteristics & Damage

Standard damage from naval mines are determined using the specific mine characteristics for each weapon used. For these rules, as with torpedoes, simplified mine damage points are listed below.

Type	Damage Points	Examples (British)
floating contact mines (light)	100 pts (lbs charge)	Mk XIX (coastal forces only), contact.
floating contact mines (middle)	320 pts (lbs charge)	Mk XV (& submarine launched Mk XVII), contact.
floating contact mines (heavy)	650 pts (lbs charge)	Mk XV, contact.
floating magnetic mines	500 pts (lbs charge)	M Mk I, contact.
airborne ground mines (middle)	340 pts (lbs charge)	A Mk I, magnetic & magnetic/acoustic versions.
airborne ground mines (heavy)	700 pts (lbs charge)	A Mk V (Aug 1940), magnetic w parachute.
submarine ground mines	1,000pts (lb charge)	M Mk IIIG, (2 per TT), magnetic influence.
ship ground mines	1,500pts (lb charge)	M Mk IIIG, magnetic influence.
controlled mines (light)	500pts (lb charge)	L Mk II, observed.
controlled mines (heavy)	2,000pts (il charge)	L Mk III, observed.

### Critical Hit Determination for Naval Mines

As with gunnery and torpedo hits, naval mine hits may cause the standard mine damage points (roll of 4,5,6 on D6) as shown above. In addition naval mine hits are critical 50% of the time (roll 1,2,3 on D6). Consult the Critical Hit Determination (CDT) table for torpedoes and mines to determine the results. Note that critical hits from mines follow the same procedure as those for torpedoes. For this table the target's Torpedo Rating (TR) (really an underwater strength rating) is used against a D10 dice roll to determine the resulting Critical Hit Effect.

## Self Protection against Naval Mines

Individual ships and submarines adopted various means to counter the increased threat from naval mines - paravanes and mine avoidance radar.

Paravanes were used by larger warships, larger merchant vessels and minesweeping vessels to avoid floating mines. At slow speeds (8 to 11kn) the paravanes would cut the mines from their sinkers so that they could be blown up on the surface or sunk by rifle/machine gun fire. At higher speeds (12 to 26kn) the paravane could only detect a floating mine and avoidance would be required. To avoid a mine a ship had to slow down to 11kn or less and manoeuvre past the detected mines. At times a floating mine would get stuck in the paravane and drag dangerously alongside the vessel concerned.

Vessels with paravanes deployed may move slowly (max 11kn) throughout offensive and defensive minefields initially without damage to themselves. The chance of hit by a mine is determined and rolled for. If a mine hit occurs the effect upon the paravane is determined by a D6 roll – 1,2 the paravane is damaged and now inoperable, 3,4 the mine is detached & drifts past, and 5,6 mine blows up with no effect. Next turn the vessel may then proceed iaw these rules – with or without its paravane. A second mine hit may not be avoided w/o the paravane. The message is to always avoid known minefields.

Maximum speeds for using vessels deploying paravanes were: up to 16 kn for merchants, up to 22kn for battleships & up to 26kn for cruisers. Bismarck for example could not use its paravanes at over 20kn due to the strain on the tow system.

Submarines transiting on the surface were subject to the dangers of naval mines as much as any other surface vessel. To avoid defensive minefields, however, submarines could submerge and try to weave their way beneath the floating mines and past the mine cables connecting them to their sinkers, all the while avoiding contact with any mines. Some submarines were fitted with automatic cable/net cutters and protected propellers for this purpose. It was dangerous but possible, more so for small submarines, miniature submarines, X-craft and human torpedoes. During WWII there remained the problems of seabed mines (magnetic & acoustic), controlled mines and various forms of anti-submarine explosive netting. Later in the war various nations deployed anti-submarine floating mines which deployed and operated at considerable depths.

Submarines that wishes to transit below a minefield consisting of only floating mines may submerge and move through the minefield, up to ½ its maximum submerged speed, without risk of hitting a floating mine. When anti-submarine submerged floating mines are used then normal rules apply.

To minimise the risk of vessels activating a magnetic mine individual ships were degaussed (or demagnetised). By reducing or eliminating their magnetic signatures each degaussed vessel could move through relatively shallow waterways (going into and out of harbours or major river systems) without fear of activating magnetic mines. Degaussed ships do not activate magnetic mines, they hit floating mines just like other vessels.

Mine avoidance radar was installed, from 1941 to 1945, on some larger warships. When fitted the radar could detect floating mines up to a range of 1,000yds. To avoid a mine a ship had to slow down to 11kn or less and manoeuvre past the detected mines.

Vessels with mine avoidance radar may move slowly (max 11kn) throughout offensive minefields initially without damage to themselves, although here is still a chance of hitting a mine (with a 10% reduction in chance of hit).

## **Minesweeping**

One of the most effective methods to clear mines from an area was to use small vessels to sweep the mines. Minesweeping was used to sweep channels used for ship movements into and out of ports/harbours as well as along important shipping/convoy routes. Quite often it was too risky for warships and/or merchant vessels to use various waters, especially choke/focal points, due to the danger of recently deployed offensive minefields, unless they were swept. In addition, minesweepers were used to clear known enemy minefields to improve seaborne communications and likely invasion routes. An important implication of this is that every warship involved in a campaign or naval operation had to keep to known mine-free safe routes, swept channels that were frequently re-swept, and such warships could not just move along any route at sea without undue risk.

For these rules the majority of minesweeping actions are undertaken at the campaign or operational level. It is however of some interest to explain how some minesweeping activities were conducted tactically – in case they turn up in a specific scenario. Rather than sweeping, some might suggest that the best way to counter naval mines in a campaign is to attack them ‘at their source’ by destroying the minelayers, the mine depots, and the mine factories. Various types of vessel were employed on minesweeping m/s duties – from navy designed fast minewseepers to trawlers, auxiliary (incl. steamboats), corvettes and older destroyers. These vessels also performed various other duties often as patrols and as escorts.

Minesweepers from a M/S flotilla conduct numerous legs of an area by moving in echelon formation with their Oropesa sweeps extended to one side (say stbd). The lead minesweeper (Senior Officer) sweeps an edge of a channel (stbd) with its sweep leading to its Oropesa float. The second minesweeper echeloned behind stbd (200yds to side and 400yds behind) is protected by the first sweep and extends their own sweep (again stbd) to cover a third minesweeper. In this manner a wide channel, say four sweeps wide (800yds) is cleared by five minesweepers. They then turn and do the next leg of the sweep. The last minesweeper in the unit, the ‘Danner’, lays the Dan buoys that will clearly mark the swept channel for those

wishing to safely use it later. Such operations were repeated ad infinitum during WWII, by both sides, with significant losses in minesweeping ships and men.

During WWII, the Royal Navy minesweepers had cleared over 20,000 mines in almost 6 years of ceaseless effort. They had paid a high price for their successes; 45 Fleet Sweepers had been lost, together with 10 Paddle Sweepers, 3 Mine Destructor Ships, 34 MMS, 6 BYMS, no fewer than 223 trawlers and 22 other auxiliaries. Mines had claimed over a million tons of British shipping but, crucially, had never stopped access to our ports being maintained. Nor had they prevented the massive amphibious invasions that were key to the Western Allies' strategy. (Source: The Vernon Link UK, 2020 Nick Stanley, [www.vernonlink.uk/wwii](http://www.vernonlink.uk/wwii) ).

## **Two Speed Destroyer Sweep (TSDS)**

Many fleet destroyers were fitted with mine sweeping equipment to detect minefields, and where necessary remove mines, as part of fleet operations. Such destroyers would normally sweep a path in front of battleships, carriers and cruisers to avoid possible damage from mines. From 1933 many British destroyers were fitted with TSDS for this purpose. The British TSDS, being typical of those used by all navies during WWII, is used for all navies in these rules.

The Two Speed Destroyer Sweep (TSDS) was towed behind a single destroyer using two paravanes (Type S Mk I) to detect and clear floating mines. Sweep deployment took 6 minutes (2 turns) with a maximum ship speed of 8kn. TSDS had a low speed setting for mine sweeping, including cutting out and destruction of floating mines. Low speed was 8 to 11kn with a mine clearance spread of 245yds behind the destroyer. In this mode all mines detected are cut away and cleared. TSDS also had a high speed setting for mine detection only. High speed was from 12 to 17kn with a clearance spread of 150yds. In this mode mines were detected so following ships could slow down (11kn or less) and manoeuvre to avoid the floating mines.

Single destroyer TSDS sweep spreads:	High speed = 150yds	Low speed = 245yds
Two destroyer TSDS sweep spreads:	High speed = 220yds	Low speed = 400yds
Three destroyer TSDS sweep spreads:	High speed = 280yds	Low speed = 550yds
Four destroyer TSDS sweep spreads:	High speed = 365yds	Low speed = 700yds

## **Minelaying**

While discussing many details of mine warfare these rules have yet to explore how naval minefields were laid. As expected for these rules the majority of minelaying actions are undertaken at the campaign or operational level. Minelaying ships do turn up from time to time in surface actions but that, of course, was not their primary purpose while aircraft and submarines were also used extensively as minelayers. It is of some interest to explain how some minelaying activities were conducted tactically – in case they turn up in a specific scenario.

Mines were placed onboard warships, auxiliaries, submarines and/or aircraft. Prior to laying/launch each mine had to be readied, prepared and set. Preferably storage and readying was undercover. On a surface vessel, they would push individual readied mines out on a rail in preparation for launch. Submarines would have two or three mines per torpedo tube pre-set for launch. An aircraft would also have mines preset for launch (like an aerial torpedo). Once the navigator confirmed the minefield location the mines were expelled at regular intervals to maintain a set

distance between mines along the mineline. The average time between mines was 15 seconds (for those ready to launch) allowing up to 12 mines to be launched per 3 minute turn. Submarines and aircraft would need to reload their mines in torpedo tubes or bomb/torpedo racks before they could launch their next complement of mines. A fast minelayer would be able to stream out its full complement of mines along rails at the maximum rate of 12 mines per turn for every rail it has. Mine launching ships must not change course and maintain their speed at no more than 2/3 of their max. Submarines laying mines must move straight ahead on the surface, or at a constant depth (not below 30 feet) while they lay mines. They also have to maintain a speed no more than 2/3 of their maximum (either submerged or surfaced depending on which state they are in). Aircraft also have reduce their speed to no more than 2/3 max., and to fly straight and low (cf. torpedo attack) in order to lay their mines.

Examples:

HMS *Abdell* with 156 mines and two mine rails (in the mine deck beneath the main deck and stern), could lay up to 2×12 mines per turn – taking 6 ½ turns (under 20 minutes) to lay its full complement of mines. It would need to keep a speed at 26kn or lower and maintain course.

The German submarine U-701 carrying 15×TMB mines (three per TT – 4 bow & 1 stern) could lay all 15 mines without reloading. Travelling submerged at 5kn (max. 7.6kn) on a straight and level course for the time taken to launch mines. It would take an average of 3 min 45 sec to launch – firing TTs one after another 45 seconds apart.

An RAAF Catalina flying boat wants to lay a minefield of two x US Mk 12 Mod 4 magnetic ground mines, carried under the wings (in the torpedo rack positions). At a speed of 112kn (2/3 of max 170kn) the Catalina has to fly straight and low for 30 seconds to launch both mines together.

It is important to maintain good records of where and when minelaying efforts occur in a campaign or operation. For instance the Balikpapan operations in 1945 involved residual minefields left by four nations (Dutch, Japanese, American and British) over four years of war, 1941-45. The Japanese did extensively use minefields to defend harbours, as barriers to enemy submarines and warships, and as obstacles against invasion. This included large fields of moored contact mines and contact minefields containing mines with charges up to 1,100lb as well as large quantities of booby traps to ensnare minesweeping vessels, equipment and clearance diving personnel.

## **AMPHIBIOUS WARFARE & COMBINED OPERATIONS**

The naval aspects of amphibious operations are rarely wargamed, perhaps because much of the decision making and associated activities are undertaken at the strategic or operational levels. Before an amphibious operation can commence, it is first necessary to secure control of the sea – on the surface, in the air, and beneath the sea. This involves those tactical aspects of naval warfare already covered by the above rules. Before, during and following an amphibious operation, friendly naval and air forces must deter or defeat any enemy naval surface, air or submarine units that may harm the amphibious forces. For example, Admiral Halsey's 3rd Fleet were meant to protect the 7th Amphibious Fleet during the Leyte Gulf operations in late October 1944, even though they were not in direct support of the amphibious operation. The naval actions forming the Battle of Leyte Gulf themselves may be simulated using these rules without any special amphibious considerations. If the Japanese had broken through to attack the transports, landing craft and support forces, even that combat could be simulated using the standard rules.

Amphibious operations could be: a raid (involving a small force entering then leaving an enemy occupied area), an assault (against heavily defended enemy positions or unopposed), an amphibious withdrawal (moving a land force off the beach back to sea), and an amphibious demonstration (threatening to land). All four involved the ability to put (or remove) an armed force ashore, with its supporting arms, and with its supplies. Amphibious assaults required detailed planning and preparation.

All associated units were brought together at the correct time and place. Safely moving from assembly areas to the battle zone from which the actual landings were made. Amphibious forces conducted the assault with support from the sea and air, as well as protection from covering air and sea forces. The ground forces once ashore established beachheads that were susceptible to enemy counter-attacks, unless the beachhead was heavily reinforced with more troops, tanks, artillery, vehicles, ammunition, fuel, food and other supplies. Captured airfields, ports, and wharves were very important for this follow-up phase. The amphibious force ashore needed to be reinforced faster than the enemy could reinforce their own defenders over land. This battle for the beachheads was, during WWII, inevitably a combined operation requiring naval, air, as well as land units to maintain superiority. Land operations are not covered within these rules, as there are a number of good alternatives available elsewhere.

The assembly of amphibious forces involved considerable advanced planning. Some amphibious operations in WWII involved the passage of large numbers of ships from various continents, travelling thousands of nautical miles. Each transport vessel had a proscribed load of troops, fighting vehicles, specialist equipment, ammunition, and other supplies, that needed to be loaded in such a way that they could be rapidly unloaded into landing craft or other assault vehicles for the trip from ship-to-shore. At times, ships arrived in the battlezone without ‘tactical-loading’, ie. they were loaded normally, and this inevitably generated considerable friction during the assault and follow-on phases.

During the preparations for the 1915 Gallipoli landings many transports arrived at Lemnos base with normal-loaded cargoes. They had to be sent back to Egypt to be ‘tactically-loaded’ and thus the landing was delayed until 25 April. By 1945 you would think that the lesson would be learnt, however before the Balikpapan landings of 1 July, Australian Army personnel removed parts of the RAAF radar equipment from the transports replacing them with more practical Army stores. Once ashore the Balikpapan beachhead had no Early Warning Air Defence Radar, but it did have some very unhappy RAAF servicemen!

### **Preparation Phase**

Prior to any amphibious raid, landing or assault, the area concerned required detailed intelligence and often reconnaissance. From the naval perspective, this may involve hydrographic & survey units, beach reconnaissance parties, minesweepers, and perhaps undercover agents, local supporters, and/or coastwatchers. The beach gradient, sand/gravel bearing capacity, and waterline obstacles were just a few features that had to be examined. Such activities may form a special scenario for simulation within these rules. Beware not every beach is suitable for an amphibious landing.

Unless there was a surprise assault, it was normal to soften up the defences prior to landing any troops ashore. This involved gaining air superiority over the area, bombing shore defences and other targets. From a naval perspective, such preparation may involve shore bombardments, particularly against naval shore batteries, mine clearance activities, and marking channels with buoys, navigation lights, or other markers. Often such forces came under fire well before the planned D-Day. Covering naval units maintained control of the seas in the battle zone – on, over, and under the sea. All types of naval fighting vessels participated in these ‘covering’ tasks.

### **Amphibious Assaults – Unopposed Landings**

When there is little or no opposition, an amphibious force could use the sea to manoeuvre a landing force to a desired position limited only by the speed of the vessels involved, and how fast they could unload their cargoes of troops, equipment and supplies. While individual ships had a carrying capacity which could be discharged rapidly at a harbour using the ship’s own booms/cranes and

shore cranes. On average troops and other personnel could disembark within 1 hour, but their equipment and other cargo would take much longer to put ashore, sort out and get ready for action – let's say for a fully equipped harbour 1 day, and for a standard harbour 2 days. There was also a capacity limit at most ports/harbours and some vessels would be waiting for days, if not weeks, before they were slotted in for unloading. This was avoided by good planning during an amphibious operation. Amphibious forces had the advantage that they could land troops, equipment and supplies over a beach using specialist vehicles to move from ship-to-shore.

During the early part of the Pacific war the Japanese effectively used converted merchant ships as transports fitted with Diahatsu landing craft. Amphibious doctrine was for troops travel to the destination in the transport and then to move from ship-to-shore in one of these landing craft. Landing with little or no opposition they would then manoeuvre to achieve their objectives – such as the capture of an airfield, seaplane base, or harbour. The Americans used a similar amphibious doctrine at Guadalcanal in August 1942, landing from transports using Higgins boats, also known as LCPV landing craft.

### **Amphibious Assaults – Opposed Landings**

During WWII experience soon revealed that amphibious force's were almost always forced to land against a determined opposition, and an assault against strong opposition was a much more complicated matter. Such 'invasions' involved large numbers of ships, smaller craft, and aircraft formed into forces, groups, or units depending on the missions that they were required to perform. Typical naval amphibious forces included: an amphibious command ship; transport groups with their own destroyer screen (and carrying landing forces); fire support groups (possibly including BBs, CAs, CLs, & DDs); follow-on or reinforcement groups with destroyer screen/escort (and more landing forces); (if possible) escort carrier group (with CVEs providing air support to ground forces); close covering group (CAs, DDs, covering amphibious forces); minesweeping & hydrographic group; beach demolition group; motor torpedo boat group; and seabased logistic/supply services group. In addition, air elements would include: fighter groups, bomber and ground support groups, as well as coastal & seaplane groups. Land forces, which had units to fight for, win and hold the beachhead, would also provide some beach control parties, and shore-based supply and transportation parties.

Amphibious operations were, indeed one of the most complex activities undertaken by naval forces during the war. Specialist training and experience was required to guarantee success, and to minimise casualties. Inter-Service naval gunfire liaison officers (NGLO) and shore fire control parties (SFCP) were necessary to

coordinate fires from ship-to-shore. Command and communications organisations needed to be under a single commander, capable of rapid informed decision making, doctrinal development, plans approval, with a system capable of rapid transmission and execution of orders. Intelligence actions, including photo reconnaissance, informed the amphibious planning process. Amphibious assaults were indeed won during the planning phases.

The importance of naval gunfire support (NGS) was increasingly recognised as the war progressed. Initially surprise was preferred to pre-landing softening-up naval bombardments, however experience revealed that whereas naval gunfire may suppress enemy coastal defences during a landing, it was the preliminary bombardment, sometimes over days, that actually destroyed hardened coastal defences. By 1944, the Allies had learnt that battleships with 14-inch and 16-inch guns could destroy enemy blockhouses chunk by chunk. Medium calibre guns could destroy bunkers and other weapon positions using direct fire from close range (~2000yds). In these circumstances large amounts of ammunition for the large naval guns was required. Ships often had no choice but to go one to one with coastal batteries, as the alternative was a much more costly attack by unprotected ground forces. Once a target was suppressed, ships frequently anchored in the vicinity to improve accuracy of their fire. At night naval gunfire support included large numbers of starshells to illuminate the battlefield.

Aside from designated pre-assault targets, naval gunfire support was used to interdict enemy reinforcements. Road junctions, bridges, and other concentration areas were especially vulnerable to naval gunfire in the open. At times troops, tanks and supplies essential for counterattacks were thwarted by naval gunfire.

Naval gunfire against concrete bunkers was much more difficult. Bunkers were often sited to avoid observation or direct fire from offshore. False bunkers were used to confuse the invader. This is where SFCs were necessary to sight indirect fire. Long range fire from naval guns tended to hit the target roof vertically, often with minimal effect, while direct fire from short range was much more accurate the effect of such direct fire was limited by the need for the shell to penetrate or enter the firing embrasures. The major effect of naval gunfire against reinforced concrete or coconut palm bunkers was the suppression of the gun crews. If times well this would facilitate the bunker's attack and capture by land forces.

Aerial bombing was also a major component of the support necessary for an amphibious assault. As with naval gunfire support, aerial bombing could be targeted at hardened coastal defences, the interdiction of reinforcements, or to suppress defensive fires. Perhaps the most important targets by aircraft in support

of an amphibious assault was the opponents aircraft, ground staff, and airfields. Amphibious operations during WWII were only successful when air superiority had already been gained, and that air superiority needed to be maintained throughout the whole operation. Noting that it was much easier to sink 5,700 soldiers with their equipment with their transports at sea than to fight them in defensive combat on the ground – eg. the Battle of the Bismark Sea February 1943.

### **Landing Craft Assault Waves**

Precise landing plans, meeting specific local conditions, the nature of the enemy, the capabilities of one's own forces, and the natural geography of the objective area, were developed to secure the beach. The actual assault landing often involved numerous waves of amphibious assault craft, including many specialist types of amphibious craft aimed at a rapid build-up of land forces and combat power on the shore. Enemy resistance, underwater obstacles, wire, mines, and booby traps, as well as weather, waves, swell and tides all seemed to try hard to defeat the landing. Each assault wave was given tasks to complete, timed to bring maximum force to bear with the right weapons to contribute their own part to the overall mission.

For example the first wave of the plan for Omaha beach, Normandy 1944, was of amphibious tanks aiming to provide suppressive fire against strong pockets of German resistance. A few minutes later the assault engineering teams were to arrive with detachments of protective infantry to clear the mines and other obstacles to form paths for the third and subsequent wave to use when they pushed further inland towards the beach exits. Unfortunately the plan did not survive the actual conditions and the execution of the Omaha landing was somewhat different.

High levels of seamanship and boat handling of landing craft was required. Kedge anchors were positioned during the drive in towards the beach so that the craft could be winched away when the landing was complete. Unfortunately most navies relied upon newly trained reserve or hostilities only men to complete such manoeuvres. They had to learn fast by doing. During the Juno landings at Normandy, some 25% of the LCA and 31% of the LCM were lost or damaged during their first landing although almost all landed their troops and cargoes.

These landing forces had to be strong enough not only to seize the objectives, but to resist counter-attacks and to safeguard the landing zones for follow-on forces. Good organisation was key. The landing force had to be transported through cleared channels/lanes to an assembly areas, then from transports to the landing craft, from ship-to-shore, and finally they had to arrive at the beach at the same time and in sufficient force to overwhelm all enemy opposition. Minor delays in timing, changes in sea conditions, or just plain reluctance to advance into excessive enemy fire-zones, could significantly compound at times with catastrophic effects. In addition, small craft often broke down or were damaged in action, requiring recovery, repair & salvage units to act under fire so that these craft were available for later waves of the assault. The Senior Naval Officer, Landing (SNOL)

made sure that each Beach Master prevented landing craft and ships from cluttering up the beach where they would prevent others from using the boat lanes that extended from the line of departure onto the cleared sections of the beach.

Managing the assault landing to secure the beach was a complicated command and communications activity, also one hard to simulate effectively in a naval table based simulation. That said one can feel the pressure and relief of command, even in a wargame, when a successful amphibious landing is simulated and a resounding success is achieved with minimum confusion and minimal casualties to the attackers.

### **Specialist Amphibious Vessels**

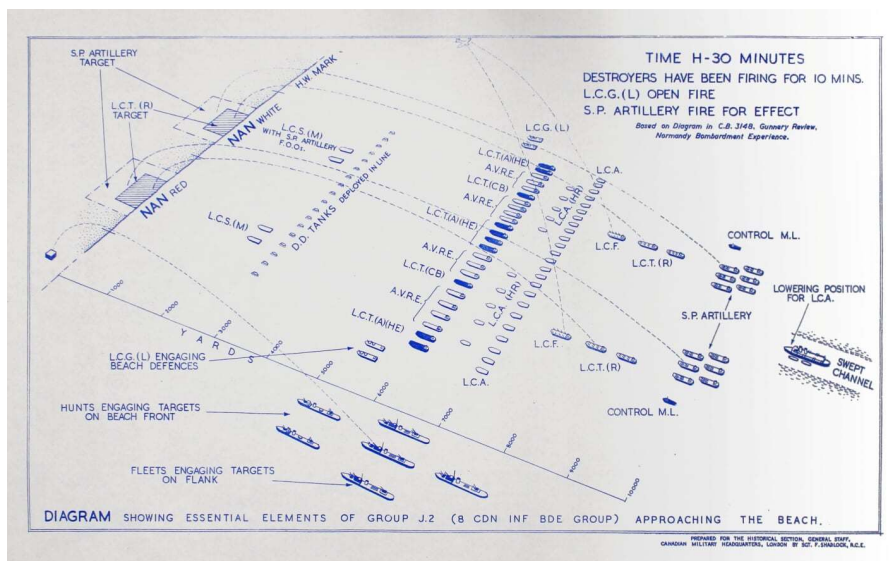
A large number of special purpose amphibious vessels were designed, produced and used operationally during WWII. In 1939 there were very few specialist amphibious vehicles. Small vessels, some Landing Craft Assault (LCA) but also ships boats or private commercial/recreational craft, were used to move people, weapons and supplies between ships, harbours and shores. Such means were slow and inefficient. They were not very suitable for sophisticated amphibious operations. It became clearer as time went on that there was no substitute for specialist amphibious shipping – particularly landing craft, amphibious ships, command and control ships, and amphibious vehicles. Landing craft were developed for assaulting infantry, tanks, artillery, specialist vehicles, as well as those that could provide fire support during the assault. Amphibious ships were capable of launching and recovering landing craft rapidly using side davits/cranes, well decks and/or bow doors. Some, like the LST were capable of landing their cargoes directly on the beach through bow doors or using a ramp. Amphibious ships with significant cargo carrying capacity and tactical loading capabilities were also developed. Command & control ships were an effective seabased headquarters that had communication and other staff & accommodation facilities. Amphibious vehicles capable of moving on both on land and at sea, such as the Alligator (LVTs) and the DUKW, were also very useful.

USN landing ships & craft included: LSV, LSD, LST, LSM, LSM(R ), LC(FF), LCI(G), LCI(L), LCI(M), LCI(R ), LCS(L), & LCT, as well as LCC, LCM, LCP(L), LCP(R ), LCR(L), LCR(S), LCS(S), LCV, LCVP, LVT, LVT(A), DUKW, and amphibious jeeps.

For example, Landing Ship Tanks (LSTs) were used extensively in invasions of Italy 1943 and of France 1944. They had bow doors that could often allow fully loaded vehicles drive off onto the beach. Engineers were required to help construct a suitable beach road for these vehicles to travel upon. Often a floating cause way (300ft) long, made of two pontoons, was used to connect the LST to the shore. After D-Day at Normandy the slow turn around left several LSTs grounded on shore. This then became standard practice with LSTs grounded on the high tide unloading until the tide returned about 12 hours later.

Auxiliary vessels were also converted for use during amphibious operations. These included destroyers & destroyer escorts converted to high-speed transports (APD),

as well as attack transports (APA), transports (AP), and attack cargo ships (AKA) converted from merchantmen.



artillery units were available. In these cases large calibre guns from battleship were able to bring down considerable accurate and destructive fires. Air support also provided bombardments in addition to the land and naval force guns, however large scale air bombardments were not very accurate during WWII – they were more an area weapon.

Reinforcements and supplies were also critical to the success of any amphibious operation. Follow-up convoys were an essential part of the planning to meet the operational objectives. These involved essentially the same actions as were required for the original assault convoys but over considerably longer time periods. Amphibious force commanders aimed to progress quickly from assault craft which could move only light loads, and to start heavy offload.

Sea and air superiority remained essential. The anti-submarine elements of the Allied navies and air forces remained alert providing their underwater barrier against which no enemy submarine could penetrate. Minefields and other obstacles were cleared, and temporary harbours and wharves were constructed to facilitate unloading. Large numbers of transport vehicles, 2½ ton trucks and jeeps, were put ashore to move essential supplies and reinforcements inland. The resulting land campaign would not be successful without such efforts.

One aspect not yet mentioned was the requirement to move casualties, prisoners-of-war, and redeployed troops from the shore-to-ship. This had to be managed along with the more traditional landing itself.

### **Amphibious Withdrawal**

World War II witnessed a number of serious amphibious withdrawals, which involved quite rapid planning and significant risks. In such circumstances it was unlikely that all parts of a land force could be successfully withdrawn, however, all efforts were made by naval forces to save as many as possible of their army brothers. The Royal Navy withdrawals from Dunkirk 1940, and Crete 1941 were some of the most dramatic amphibious withdrawals of all time. With half his fleet crippled or lost the Admiralty order Admiral A.B. Cunningham to stop the evacuation of Crete. He replied: 'It takes the Navy three years to build a new ship. It will take 300 years to build a new tradition.'

### **Raids from the Sea**

The Dieppe raid of 1942 was a large scale assault landing that was cancelled and ended after a pre-prepared withdrawal was ordered. Like other amphibious raids with precautionary withdrawal orders, Dieppe was perhaps too big to be called a raid (this is debatable). Amphibious raids involved a rapid move to objective,

execution of the mission objective, and a pre-planned re-embarkation of the force. Amphibious raids were generally much smaller affairs than assaults or withdrawals. Typically raids involved 100's or 1,000's of people instead of 10,000s. The Lofoten Island 1941 raid, the St Nazaire 1942 raid, and Makin 1942 raid in the Pacific are perhaps better examples. Although parts of these rules may be used for some aspects of an amphibious raid, it is recommended that suitable WWII skirmish rules would be more suitable.

### **Naval Gunfire at Coastal Defences**

In simulations where significant land combat is involved specific Land Simulation rules for World War II should be used. The following rules are provided, however, for when it is desirable to simulate naval gunfire against coastal defences or other land targets. Overall naval gunfire against coastal defences is conducted using a method similar to that used for surface ship gunfire (see above section).

Coastal defences are divided into two groups: troops and guns in fortified positions (using reinforced concrete protection), and troops, and vehicles in open ground (including those dug-in to some extent). Ships fire in the same way that they fire at other surface vessels, except that the land targets do not move – they do not deduct a target Speed modifier.

### **Naval Gunfire Support (NGS) – Hit Probability**

All of a ship's guns, which are able to bear, can fire whenever an enemy land target is detected and within maximum gunnery range. Coastal batteries, whether in fortifications or in the open, may also fire at naval vessels, including landing craft, that are detected and within range. NGS is limited to targets that are clear of friendly troops – for naval guns 3-inch to 6-inch the clearance must be 500yds or more, and for naval guns over 6-inch 1,000yds or more.

All naval gunfire support (NGS) and coastal defence fires (CDF) is conducted by battery. The range is measured from the bow of the firing ship to the mid point on the leading edge of the land target. The number of guns able to fire is determined by looking at the individual arcs of fire for every gun attempting to shoot. When ships fight one-on-one with coastal batteries, the ships always fire first as they may suppress the return CDF.

The procedure for simulating NGS and CDF follows.

1. Firer states intended fire – types of gun, numbers firing and targets.
2. Measure range in yards and determine ship/battery target factor (STF/BTF) and target speed (kn).
3. Consult Naval Gun tables to determine the gun factor (GF) per gun firing. Then multiply this GF by the number of guns able to fire, to determine the basic hit percentage.
4. The basic hit percentage is modified by table below – increased by the Target's Size modifier, decreased by the Target Speed modifier, decreased by the Target Range modifier, and by the other modifiers listed.
5. The hit percentage is then modified by any factors such as the use of spotting aircraft (+10%) or the use of early war radar (+10%) or late war radar (+20%).
6. Rate of fire for battery guns. For 12-inch to 18-inch guns x 1. For 5.9-inch to 11-inch x 2. For 3-inch to 5.5-inch x 3. The overall hit percentage then is Hit Percentage (from 5) x Rate of Fire.

At this stage two D10 die are rolled to see how many naval gunfire 'hits' occur. Noting that an overall hit percentage of 125% is one automatic hit and a 25% change of a second hit.

#### **Naval Gunfire Hit Modifiers**

Target Size modifier - calculate and add  $(STF - 15)/2$  to the hit probability.

Target Speed modifier – calculate and subtract  $(Knots - 15)/2$  from the hit probability.

Target Range modifier – subtract 1% from the hit probability for every 1,000yds range.

If the target ship is conducting 'radical manoeuvring, the hit probability is halved ( $\times \frac{1}{2}$ ).

If the target ship is behind a smoke screen, the hit probability is halved ( $\times \frac{1}{2}$ ).

#### **Coastal Defences - Hit Determination**

Every gun 'hit' will suppress the land target aimed at. Suppression means that the land unit will not fire or move during each turn that it is hit, as well as for one additional turn. For example, a coastal battery of 4x6-inch guns in reinforced concrete bunkers will be suppressed (cannot fire) for each move that it is hit, and will remain suppressed for at least 3 minutes (1 turn) after the last time it was hit. Every gun 'hit' effects a land target as standard hits - an NGS hit is never critical.

Fortifications were typically made of reinforced concrete, metal armour, or dense materials such as coconut palm logs. Such defences have armour equivalent to their warship ship counterparts. A1 'belt armour' refers to the front and sides of the fortification, while A2 'deck armour' refers to the fortification's roof. Note that when calculating armour penetration for naval guns metal armour is assumed. Metal armour is equivalent to  $1/2 \times$  the thickness of reinforced concrete and/or palm logs, and  $1/5 \times$  the thickness of soil. A 12-inch thick Japanese bunker made all around from palm logs has an equivalent armour strength of 6/6/-/-/. The German 4x100mm gun coastal battery at Merville, Normandy had four steel reinforced concrete casements up to 6 feet (72 inches) thick. Other concrete buildings included a command bunker, crew accommodation, and ammunition magazines. The area was protected by trenches, bunkers, wire, minefields and an anti-tank ditch. For these rules Merville Battery's armour would be 36/36/-/-/. In effect this meant that the Merville battery casements could not be penetrated by any of the Allied naval guns present on D-Day. They could, however, be degraded and suppressed.

Land targets, whether fortifications, batteries, troops, vehicles or supplies, that form part of the amphibious simulation will need to have equivalent ship characteristics. These will include: damage points, unit target factor, guns & other weapons, and AAFF.

For the *Merville Battery* (1944): 1600pts, STF 31/20 4x3.9-inch, 1x20mmAA, 4xMG. AAFF 05. Armour 36/36/-/-.

A battery that has lost damage points also proportionally loses the ability to fire a gun. So for the *Merville Battery* after losing 400pts would be down to just 3 guns.

If the damage points are reduced by 1/3 the artillery crew take a morale test, and again at 2/3. Troops in fortified positions will not run away rather they will stay under cover in a 'suppressed' state. Troops in the open or dug-in may withdraw to safer positions. Land forces may remain under cover within fortified positions, even when they have been reduced to no guns and no points.

**General Guide.** Damage points per gun in fortified battery may be calculated thus: 18-inch guns 7000pts each, 14, 15 & 16-inch guns 5500pts ea., 12-inch guns 4500pts, 8-inch 2200pts, 5.9 & 6-inch 1200pts, 4.7 & 5-inch 600pts, 4-inch (102mm) 400pts, and 3-inch (76mm) 300pts. So in above example 4x100mm gives 4x400pts or 1600pts. Also maximum length of defended area in feet divided by (3x22.5) equals the equivalent STF.

### **Standard Gunnery Hits against Land Targets**

Standard gunfire essentially generates a gradual attrition of a coastal defence or land target's strength. For armoured coastal defences the hit causes ED points only. For unarmoured defences, batteries, land forces, and/or supplies the hit causes ID points (or 3 x ED points). All damage caused by naval gunnery hits (found in the Naval Gun Characteristics tables) are taken away from the land target's 'damage point' total as identified for each land target. There are no critical hits for NGS against land targets.

### **Air Attacks against Coastal Defences and Land Forces**

Whenever an Air Group (AG) wishes to attack a coastal defence position or land force target it is undertaken using the same procedure as that used against surface warships which are stationary or anchored. Aircraft can conduct level bombing, dive bombing or strafing attacks against Land Targets, although level bombing may be from either HA or LA. In addition they can drop either GP or AP bombs.

## Aerial Bombing against Land Targets - Basic Hits & Modifiers

The following percentages are used to determine the basic chance of aerial bombing hits against land targets.

Form of Air Attack Bombs Dropped	Dive Bombing (AP & GP)	Level Bombing LA (AP & GP)	Level Bombing HA (AP & GP)
Chance of hit per bomb	60%	10%	2%

### Bombing Hit Modifiers

Target Size modifier - calculate and add  $(STF - 15)/2$  to the hit probability.

If the land target is behind a smoke screen, the hit probability is halved ( $\times \frac{1}{2}$ ).

The percentage chance to hit of each bomb, after modifiers, is then multiplied by the number of bombs (of the same size) dropped by all the aircraft in the Air Group. The resultant percentage is the Overall Chance to Hit with that size bomb.

Aerial bombing hits may only cause the standard damage points (equivalent to the weight of the bomb) against land targets. Air attacks against coastal defences or land forces can never be Critical Hit.

When GP bombs hit a land target their weight in lbs is used as their 'damage points', so a 500lb bomb causes 500 damage points. AP bombs that hit armoured coastal defences also cause their own weight in damage. If however AP bombs are used against unarmoured land targets their effect is  $\frac{1}{3}$  the damage that would result against a ship. For example a 500lb AP bomb dropped on an AA position would only cause 166 points damage.

## Inshore Patrols and Bombardments

Large warships and merchant vessels move through known channels where they know the water is deep enough for their draughts. For instance the battleship *HMS Warspite* had a draught of over 32 feet (almost 10m) when it conducted the bombardments off the coast of Normandy. For the purposes of these rules only smaller ( $STF < 10$ ) vessels are capable of operating inshore (less than 5,000yds from the high water mark on the shore. There are a few exceptions, such as when operating in Norwegian Fiords, however these will need to be specifically defined in any scenario.

When small vessels conduct combat operations inshore ( $< 5000$ yds) they are subject to the same NAVSIM rules as are used in deeper waters with a few modifiers. For observation, surface objects on the ground cannot be observed or detected visibly or with radar if there is any raised ground, obstruction, or building between the ship and the target. Low altitude aircraft also cannot be observed or detected by inshore vessels until they cross the shoreline and fly above the water.

There is no adverse effect on the observation or detection of high altitude aircraft. Any submarine that is inshore when attacked by an aircraft from the land, can only react during the time it takes that aircraft to approach from the shoreline, and of course submarines need to watch out for the maximum depth in inshore waters. When an inshore vessel cannot detect a target, it cannot fire at that target.

Inshore vessels may use camouflage to hide themselves against a coastline which is covered with dense forest, jungle or other objects that will break-up the detectable surface of the inshore vessel (STF<10). Small cruisers and destroyer sized vessels (STF10-20) may also elect to hide themselves along a coastline in inshore waters. They have to move into a position (from 5000yds) at 2kn or less and then anchor, before applying suitable camouflage coverings. Such larger vessels attempting to hide cannot engage in combat until they depart the inshore waters. Hidden vessels cannot move or fight when an opponent is in standard observation/detection range. There is a 5% chance of a small inshore vessel being sighted by an enemy (one roll only), and a 10% chance of larger hidden vessel being seen.

During the later stages of the Pacific War, Japanese supply barges and at times submarines used dense jungle foliage to hide from enemy observation. In the Mediterranean small MTBs and caïques used by special forces were often hidden amongst the broken & rocky shorelines of small inlets.

### **Motor Torpedo Boat Actions**

One of the most exciting aspects of the naval war were the encounters between motor torpedo boats (MTBs) in coastal waters. MTBs include all small, fast craft armed with torpedoes or small calibre guns. The USN PT boats were famous across the Pacific for their ability to perform a great variety of tasks mostly while avoiding being sunk by larger, more powerful ships or aircraft. German Schnellboots had similar if not more deadly experiences in the English Channel and the North Sea as they were matched by the RN Vosper Type MTBs and Fairmile. The Mediterranean was their playground as the famous Italian MAS boats gave way to British and American boats. The Germans countered with heavily defended F-lighters. The Japanese did use some patrol boats but by 1945 they were rapidly producing suicide boats, hoping for large warship targets. Together they were all the buccaneers of WWII, using speed as their weapon.

This NAVSIM rule set can be used for combat between MTB and larger vessels. The sections on 'Small Calibre Fire against Minor Vessels' as well as on 'Ramming' are perhaps the most relevant here. Torpedo fire, aircraft attacks, and other sections will need to be used whenever relevant, however due to the great speed and manoeuvrability of the MTB it is necessary to simulate their movement using the same methodology as aircraft. Note that for large numbers of MTBs it

may be preferable to use one model for every three boats. At the beginning of a turn, light attack craft move up to an attack position 2000yds from their target(s).

All MTB models may move up to their maximum speed in knots per 3 minute game turn. In effect this means 1cm move per knot of speed each turn. A PT boat moving at 40kn moves 40cm on the table per turn (3 mins). Whenever both sides have MTBs involved in tactical combat, each player rolls (D10) for initiative and the higher roll goes first.

When MTBs attack surface targets (ships and/or bases) the ships move before the MTBs. MTBs then conduct their movement until they reach a position 2000yds (20cm) from the ship they are attacking. Naval fire and small calibre fire against minor vessels combat is then resolved – including revealing type and path of proposed attack, supporting and defensive AA fire, resulting attacks (torpedo, ramming and strafing attacks), and remaining MTB movement (the remaining move distance per turn). Whenever there is more than one MTB attack against the same enemy ship, the attacking player decides the order in which each MTB force/squadron/group attacks while the defending player decides what proportion of its ship's AA fire to direct against each MTB. Note a defending ship can split its fire but it can never fire more than 100% of its AAFF per turn.

During defensive AA fire attacking MTB may need to turn away, due to damage and the moral rules. A turn away movement involves a 180 degree turn followed by a movement (the remaining move distance per turn) directly away from the major concentration of small calibre fire. Note all MTB movement is very flexible and each crew are assumed to use minor variations in position whenever tactical combat occurs. As with radical manoeuvring by ships, much of this is too small to see on the table.

Although parts of these rules may be used for some aspects of MTB actions, it is suggested that suitable WWII skirmish rules could be more suitable whenever close range boat vs boat MTB actions are involved.

## COMMAND, COMMUNICATIONS & INTELLIGENCE

During WWII there were two major methods of naval command – centralised command and decentralised command. Both forms of command had good and bad aspects. Centralised command was necessary during much of World War I (WWI) due to the limitations of the communications available to commanders. In order to maintain formations at sea, and to fight as coordinated units, squadrons and fleets strong centralised command at sea was necessary. However during WWI the use of wireless telegraphy meant that it was possible to command fleets and ships from ashore. During 1914-16 the British Admiralty attempted to direct naval operations centrally from London. They argued that only the Admiralty's Naval Staff were in a position to know the overall situation and hence they should advise the operational commanders at sea in all except tactical actions. This process was unwieldy and at times counter productive. By the end of that war the Allied experience revealed that it was preferable to have centralised direction and decentralised execution, underpinned by a common naval doctrine.

Centralised command systems tended to be used by Authoritarian Regimes which gave orders from above and expected strict compliance and execution. For example in 1940-43 operational command of the *Regia Marina* (Italy's Royal Navy) was directed from its headquarters, the *Supermarina* in Rome. Plans were developed and orders issued from the *Supermarina* and fleets, squadrons, ships and submarines executed those orders accordingly. Fascist ideology penetrated into personal and group decision making in ways that tended to stifle initiative. Naval commanders tended to follow orders to the letter rather than risk adverse intervention from above, and when unsure they would wait for orders from the *Supermarina* who were supposedly in a better position to know what to do. Many within *Supermarina* were concerned about over centralisation of command and as a result often left those in action to decide themselves. Unfortunately this left decision making in the air, with sins of omission replacing sins of commission. The Submarine Fleet HQ at La Spezia, although directed by *Supermarina*, tended to run its own race, allowing the submarine commander's greater use their initiative while maintaining radio silence. The Italian Navy's centralised command was reflected by their counterparts in the Air, the *Superaereo*, and in the Army, the *Supereercito*. These centralised organisations limited cooperation between the three services at lower levels of command. On operations each service was reluctant to use their initiative by working alongside their land, air or sea counterparts without definitive orders from their superiors. This is not to suggest that the Italian centralised command system was all bad, indeed the German command arrangements were also centralised.

German surface ships were centrally commanded by the *Seekriegsleitung* (SKL), while the *Oberbefehlshaber der Marine* (ObdM) effectively administered the navy. Over time the SKL lost command of ships in German home waters, and then submarines which were commanded by the *Befehlshaber der U-Boote* (BdU) directly under the Commander-in-Chief. In this case the direction of the German Navy was split into several silos each with its own centralised command headquarters. At the tactical level decentralised or 'mission' command was the norm for German officers. In some instances centralised command worked very well. For U-boats where the organisation expanded rapidly with little time for advanced training and where commanders were frequently lost, there was a shortage of experienced submariners. The centralised direction from Admiral Dönitz at BdU ensured that the Battle of the Atlantic would be executed in the most efficient manner, without undue heroics and unsupportable losses.

In this Rule Set centralised command is represented by the need for all naval forces under such commands having to follow their orders exactly without variation. If commanders want to change their orders they must signal their superiors and wait for new orders, with associated time delays. Their applicable fleet standing orders are there to be obeyed not discussed. Radio transmissions must be used to frequently update the centralised command on the situation, and to confirm changes of orders.

The American and British approach to naval command during WWII was based upon centralised direction and planning, decentralised control and execution, and familiar doctrine. It was important for those in command of ships, submarines and aircraft to use their initiative and not refer back to higher authority. Their responsibility was to make sure their actions support the plan. During WWI Admiral Beatty had recognised that wireless transmissions (W/T) did not replace leadership, training and doctrine, and he stressed that command systems had to promote initiative, vigorous offensive action, and a willingness to destroy the enemy fleet. He believed that the German Navy had overused their W/T and that the Royal Navy had to learn to fight at night with radio silence. During WWII the Americans and British started with formal doctrine, the US Navy's *Sound Military Decision* (1940) and the RN's *The Fighting Instructions* (1939), however it was the theatre level naval doctrine and subordinate tactical procedures, that helped to inform many ship, submarine and aircraft commanders in the maritime environment. For these Rules naval doctrine applicable to the circumstances of the campaign and/or operation shall be used.

If a player wishes to depart from standard doctrine, in a manner that involves greater danger, then a 'bravery' roll is required. They must roll a D6 for bravery:

For Allied Navies 1,2, the ship withdraws out of range and avoid combat, 3,4,5&6 the ship risk all and fights on.

For Axis Navies 1,2,3 the ship withdraws out of range and avoid combat, 4,5&6 the ship risks all and fights on.

Decentralised command did not always work in the manner desired. One of the most famous breakdowns of command and control occurred with "Bull's Run" during the Battle of Leyte Gulf in October 1944, when Admiral Halsey pursued the Japanese carriers to the north leaving the invasion force exposed. Admiral Nimitz in Hawaii had delegated command of the 3rd Fleet to Halsey with imprecise orders. Once Nimitz observed the gap left by Halsey's movements he failed to intervene not wishing to interfere with Halsey 'at the coal face'. The result came close to a major disaster for the Americans.

Command at sea has been defined by the absolute authority of the ship's captain, and traditionally sea command, often exercised at great distances from its bases, was by necessity decentralised. With the introduction of radio communications, it demanded that the commander-in-chief had to state their intent clearly so that a ship's captain could operate in accordance with a larger plan. In these rules, the ship remains the smallest unit under tactical command. Likewise the pilot of each aircraft exercises tactical command of that aircraft and its crew. The aircraft being the smallest unit under tactical command.

Naval command and control for the first few years of WWII (1939-41), was delegated along traditional lines. The chain of command ran from Naval Headquarters to Fleet Commanders, who then delegated command to their squadron and flotilla commanders. Ship's captains could be delegated command of a collection of ships for specific missions, however relative ranks and seniority took precedence over actual abilities, performance or specialist knowledge. Seniority is used to determine subordinate commands in these Rules up to 1941.

During 1942, mission command involving Task Forces became much more common. In these cases Task Forces (TF), Groups, Units and Elements were established within Operational Plans to execute clearly defined tasks and activities. These forces were not permanent but would evolve over time. Some ships would form part of different TFs during the same operation depending upon function, while other TFs may lie dormant until activated if and when required. Mission command is to be used along with these Rules for commands 1942-45.

### **Naval Ship Communications**

Ships at sea have numerous ways to communicate between each other, and to communicate between themselves and those ashore. Messenger and mail systems were used at times for more formal, less time critical communications (by hand). Visual systems between ships included: flag hoists and Semaphore signalling, signal light lanterns in daylight, flashing lights at night, time balls and other timing signals, loudspeakers, sirens as well as other noise signals. Visual signalling was

limited to a maximum of 12nm or 24,000yds, although sea, weather and light conditions did routinely reduce its range and readability.

Visual signalling could travel up to 12nm with a 80% success rate over every 3 minute period (every turn).

Each warship has a visual signalling capability onboard able to send and receive up to 4 messages every 3 minutes.

Warships in formation, using visual signalling (without TBS) can pass tactical information including targeting, or to order tactical manoeuvres and formation changes during combat. When successful (80% die roll), all changes to tactical orders using visual signalling between warships of the same fleet may be acted upon in two turns (after a 6 minute delay).

At the beginning of the war radio communications between ships depended upon wireless telegraph (W/T) using coded naval signals. W/T transmissions were sent in the High Frequency (HF, 3-30MHz) band. These could be picked-up over long distances and were generally limited for significant communications between a ship and its command ashore. Such signals did form legal naval orders and often had command actions associated with them. Tracking stations were able to detect many of these transmissions, although strength and readability varied, and this information was used by naval intelligence units to assess ship and submarine locations and signal volumes through traffic analysis. Behind the scenes codebreakers were also able, at times, to decode significant naval signals in order to gain significant strategic and operational advantages. This was known by most navies following similar experiences during the 1914-18 war. Ship radio systems were thus controlled through various fleet communications plans and associated doctrine. For example RN doctrine stressed: radio silence, authentication, use of guard frequencies and radio watchkeeping. Whenever possible RN ships were to use visual methods to signal between ships and to avoid W/T until enemy contact was made.

HF transmissions, although they could travel 'around the world', were frequently limited by the availability of individual frequencies (as other users tended to swamp transmissions), by available transmitter power, by the size of detection aerials, and by variations in propagation conditions (such as tropical storms or cyclones). Repeating stations were used, ashore as well as at sea, to help overcome these limitations.

HF Wireless Transmissions (W/T) from ship-to-shore may travel up to 2,500nm with an 80% success rate per hour.

Each warship with W/T systems installed may send and receive a single (1) message every 3 minutes.

The ship sending a W/T signal does not know if it was received. Retransmissions are possible in subsequent hours.

Shore based W/T transmissions from shore-to-ship, or shore-to-shore may travel up to 5,000nm with 100% success.

Radio direction finding was used to locate and hopefully identify certain ships and submarines, however it was only with the introduction of HF/DF on smaller ships in 1942 that they were able to gain a significant tactical advantage. The U-boat command never did learn this lesson as they continued to micro-manage their U-boat commanders, using W/T signals, right up to the end of the war, hoping that by

limiting their transmissions to 30 seconds they would avoid HF/DF detection (which on average took 60 seconds).

High frequency radio telegraphy (R/T) using voice had been used at the end of WWI but the technology was not suited to shipborne sets. During 1940 and 41 the USN and RN trialled small (low-powered crystal controlled) R/T VHF sets capable of effective voice to communicate tactical messages between warships at sea. In the USN such bridge to bridge voice R/T communications soon became known as Talk-between-Ships (TBS). TBS sets were massed produced by the Americans and were soon introduced into the RN and other Allied navies. R/T and TBS systems operated using Very High Frequency (VHF, 30-300mHz) voice transmissions which essentially travelled just over the horizon, about the same distance as radar signals, that is up to 24nm or 48,000yds. From 1942 until the end of the war, large numbers of R/T and TBS sets were introduced and this led to dramatic improvements in tactical coordination between ships at sea. By the end of the war, Allied navies made use of numerous VHF channels and although they maintained HF W/T and R/T capabilities, their use was less relied upon. The Axis navies did not allocate priority to their own TBS sets, perhaps because by 1943 they rarely operated large surface fleets.

VHF R/T and/or TBS could travel up to 24nm with a 100% success rate over 3 minutes.

Each warship with R/T and/or TBS systems installed may send and receive up to 4 messages every 3 minutes.

During 1942-45, warships in formation could use TBS to pass tactical information including targeting, or to order tactical manoeuvres and formation changes rapidly during combat. All changes to tactical orders, using R/T and/or TBS, between warships within the same fleet may be acted upon the next turn (at the end of the current 3 minute period).

Note there were instances recorded where VHF TBS transmissions bounced off the atmosphere and travelled several hundred nautical miles, but we can effectively ignore these instances as due to quite random atmospheric conditions.

W/T and R/T countermeasures included jamming of communication signals. In order to 'jam' an enemy signals a warship must have a similar (HF W/T, HF R/T, VHF R/T, or jamming device) system installed. They must then first determine the frequency they wish to 'jam' which will take at least 3 mins. Jamming requires full-power transmission from a warship of the desired frequency. Note smaller warship types do not have enough power to effectively jam the communications of larger warships with greater power generation capacities. Hence a submarine cannot effectively jam an aircraft carrier or a battleship comms system. All jamming efforts may be detected, just as radar may be detected, by other warships with similar appropriate system capabilities.

Visual signal cannot be jammed but they can be mimicked, repeated or confused by an enemy ship using its own visual signalling staff to deceive.

Merchant vessels were not fitted with navy-grade communications suites, although sometimes small navy units with comms equipment were added for a specific mission. Merchant vessels generally operated W/T sets in the commercial bands (HF), generally using International Morse code to enhance signal transmission. The Imperial Japanese Navy did use separate coded W/T signals for merchant vessels and for their own auxiliaries, however both codes were successfully deciphered by Allied code-breaking experts. As a general rule of thumb coded W/T transmissions had 2 to 3 times the range of voice R/T using the same comms equipment.

### **Naval Shore Communications**

Traditionally orders from the Admiralty were passed by hand (safe hand) to the naval commander involved before they went to sea. Subsequent dispatches were transferred by mail (again by safe hands) until they reached their addressee. Diplomatic channels were much used for this purpose. This method was still used during WWII, especially when weighty orders/instructions or documents were passed. A member of the ship or its captain would receive such orders/instruction at a port of call, or from a dispatch boat, or even dropped onboard from an aircraft.

Communications between naval bases (and for ships alongside a suitable wharf) were by telephone (voice by wire), W/T systems (using coded naval signals), voice R/T systems (largely avoided alongside) and general radio broadcast systems (unclassified only). The Americans introduced naval teletypewriters in 1941 and then faxes (radiophoto) in 1944. In September 1945 the signed Japanese surrender documents were faxed to Washington. Of these communication systems only the telegraphic system using coded naval signals could be used to transmit messages to naval ships at sea. Note a less secure telegraphic system was also available for sending coded merchant ship signals. Morse code was used as a universal back-up for international distress calls. The strength and readability of simple Morse code far exceeded that for voice communications.

Large shore based communications stations were used to transmit W/T signals across continents as well as to ships and submarines at sea. For example point to point W/T signals were transmitted between Washington - San Francisco - Honolulu - Canberra (Belconnen) in Australia. This facilitated rapid communications across the world but involved preparing a signal, coding the signal, waiting for its transmission, timely receipt of the transmission, decoding and reading of the signal by the addressee. Thousands of these signals survive, even today, in various archives around the world. The timing of transmissions relied upon its importance with classifications identified as URGENT, OP (operational) PRIORITY, PRIORITY, and ROUTINE. It was possible to jump the queue using a 'break-in' procedure but the signal system was heavily loaded and

subject to minor processing errors. In addition signal strength and readability varied with operating conditions and, at times, the experience of the operators. naval communications organisations expanded rapidly during the war to meet the constant demand.

### **Aircraft Communications**

At the beginning of the war, and for some throughout the war, maritime patrol aircraft were fitted with hand-held signal lamps which could be used to signal surface vessels directly. Aircraft also dropped message bags, containing intelligence packs, photographs and long operational orders, onto ship's decks, airfields or bases. At times flags and signals were used to send simple instructions to aircraft operating with the fleet. The Italians, at times, used candy striping on their bows to help their aircrews recognise their own friendly ships. Such methods became less common as the war became more deadly, and greater reliance was made of wireless and radio communications. Distribution of large operational order packages using drop bags from the air remained an important activity right up to the end of the Pacific War. Some suggested that these packages weighed more than some bombs!

During WWII many aircraft had at least one wireless telegraphy (W/T) or radio telephony (R/T) set. During the later 1930s British two-seater or larger aircraft were fitted with High frequency (HF) sets using frequencies 3 to 30 MHz to transmit messages over long distances - up to 3,000km or 1620nm in ideal conditions. HF transmissions were typically W/T with Code Transmission (CW) using Morse code. HF R/T voice transmissions were also used even though R/T was less secure, more susceptible to jamming, and subject to increased electromagnetic interference. Indeed R/T range was often 1/2 to 1/3 that of similar W/T transmissions (max. 540nm to 810nm). Single seater fighter aircraft did not have CW capacity and hence were limited to R/T sets. HF sets had the advantage of providing direct long distance communications using ionospheric refraction to send signals over the horizon, they also had several disadvantages. HF sets required large transmission antennas, they had a limited bandwidth and thus could transmit limited amounts of information, and the frequency often changed with the ionosphere conditions. In addition HF transmissions could be detected and their origin traced using DF, or their content could be deciphered by intelligence organisations.

In these rules, for the period 1939-42, each ship and aircraft (with radioman) is allowed one HF W/T or R/T (voice) transmission every turn. The maximum range for ship- to-ship, and air-to-ship/ship-to-air transmissions is 1620nm for W/T and 810nm for R/T. The chance of receiving the signal from 1/2 to max. range is 50%.

The chance of receiving the signal up to 810nm for W/T is 80%. The maximum range for air-to-ship/ship-to-air R/T (voice) transmissions is 810nm and the chance of receiving the signal between 80nm and 810nm is 50%. The chance of receiving the air-to-ship/ship-to-air R/T signal up to 80nm for R/T is 80%. All communications are to be written down for every 3 minute turn. The signal message must include: sender, recipient (addressee), priority (immediate, urgent, normal, routine), transmission type (CW or in clear, W/T, R/T, HF or VHF), and the actual message (the R/T message may be given verbally). Now if the transmitted signal is not received by the recipient the message may be resent the following 3 minute turn. Note that signals can be listened to by other ships and aircraft but only the recipient may act on the message contained within. For HF transmissions only one signal may be sent and one signal received by a ship or aircraft per turn. When more than one signal is sent to the same addressee the higher priority signal gets priority (or roll a dice to see which one does get through). Note the limited bandwidth of HF communications and the one signal per turn rule may lead to signal overcrowding in action. Also mission planning of all aircraft is only undertaken on board that aircraft's specific carrier or air base, unless the aircraft are under the direction of it CIC or AIO (refer to paras below). Aircraft command involve a variety of specialised staff functions which are never available to aviators while in flight, (unless remotely via CIC or AIO). That means that in these NAVSIM rules pilots cannot decide to conduct actions that do not form part of their missions - particularly under authoritarian Axis command. Pilots, serving under a more flexible Allied power, who wish to use their initiative to make minor changes within their mission guidelines will need to successfully role a 'bravery' initiative roll.

If a player wishes their aircraft to make minor departures from a standard mission, then a 'bravery' roll is required. They must roll a D6 for bravery:

For Allied Aircraft 1,2,3&4 the aircraft continues with mission unaltered, 5&6 the aircraft risk all and acts accordingly.

For Axis Aircraft - no dice roll needed - the aircraft continues with mission unaltered.

During 1939-42, the above R/T ranges were for larger radio equipped aircraft only, especially maritime reconnaissance and two-seater carrier aircraft. Fighter aircraft did not have long range HF sets, rather they were limited by battery capacity, weight considerations and single crew operations, to relatively simple R/T sets. The British fighter pilots during the Battle of Britain in 1940 used 2 channel HF voice radio sets to coordinate their intercepts and combat, with the second back-up channel used as a directional tone. The air to surface range was 35nm (back to their station controllers), while their air-to-air range was only 5nm. At times the Japanese fighter pilots preferred to remove their simple R/T sets and use their professional training, doctrine, coupled with hand-signals and aircraft movements for tactical coordination.

For these rules, early war (1939-42) fighter aircraft can use HF R/T up to 35nm for air-to-ship, and air-to-air range up to 5nm. The chance of receiving a R/T voice signal from a single seater fighter at the maximum ranges of 35nm & 5nm is 80%. The same rules apply for limiting ship and aircraft communications to one sent and one received signal per turn, and overcrowding the communications sets apply.

Early war VHF communications gear was generally unreliable, needed large antenna and power sources which made them far too heavy. HMS *Illustrious* (CV) used 2 channels HF R/T as well as 1 channel VHF R/T for fighter direction during the Operation Pedestal battles in August 1942, and the clear advantages of VHF sets soon led to their rapid spread across the Allied navies. During 1943 as VHF equipment had improved dramatically and smaller sets were far more common, techniques evolved rapidly and soon 6 channel VHF sets were used by CVs in action along with a 7th VHF channel available as back-up. Initially VHF sets were used to supplement the HF comms, providing multiple voice connections for shorter range applications - typically line of sight. In fact VHF was really limited by the horizon plus about 1/3 distance due to refraction in the atmosphere - typically with a range of 30nm (45nm maximum).

For the period 1943-45, each ship is allowed to supplement its single HF W/T or R/T (voice) transmission every turn with up to 6 VHF R/T transmissions. Each aircraft can only transmit one HF or one VHF message per turn. The maximum range for VHF transmissions is 45nm. The chance of receiving each VHF signal from 15nm to 45nm range is 80%, while the chance of receiving the signal up to 15nm for W/T is 100%. All ship VHF R/T communications are to be listed for every 3 minute turn. The radio message list is used to determine the six R/T messages sent and/or received by each ship. If the transmitted signal is not received by the recipient the message may be resent the following 3 minute turn. Note that voice messages can be listened to by other ships and aircraft, if they are in range, but only the recipient may act on the message contained within. Note the greater bandwidth of VHF communications and the six signal per turn rule helps to avoid or at least minimise signal overcrowding in action.

### **CIC and AIO**

The British first introduced an early form of the Air Information Organisation (AIO) in 1941 when using HMS *Illustrious*'s radar to prepare fighter control plots and vector fighters out to 30nm in the Mediterranean. Experience led to combat air patrols (CAP) being situated approximately 25nm from the carriers, to improve recognition and to avoid friendly AA fire. German 'shadower' aircraft were early targets and fleet observation became a very dangerous business. Such early experiences evolved rapidly as improved voice communications between ship and

aircraft, advanced radars capable of tracing aircraft movements, and the widespread introduction of IFF (Identify Friend and Foe) were introduced. By mid 1943 both RN and USN carriers had an AIO, or as the Americans called it a Combat Information Center (CIC). Aircraft could be vectored out to 80nm with up to four intercepts controlled at one time by the CIC's 'Fighter Direction' system. By late 1944 the terminology had changed to 'Aircraft Direction' as both offensive and defensive missions were commanded through the relevant CICs. CICs used vertical plots to record aircraft movements and assess the action required. Such methods worked extremely well against the Japanese method of concentrated aircraft attacks, used to avoid excessive AA fire, at the Philippine Sea 1944.

At Okinawa, in April 1945, Japanese kamikaze aircraft came in dispersed single aircraft attacks, with rapid changes in direction and height, as well as deceptive approaches using split approaches, false run-ins and cloud cover. When confronted by an American CAP, Japanese aircraft rapidly retreated to avoid combat. The USN CICs were saturated and those in command of 'aircraft direction' were overwhelmed. The CIC vertical plots inevitably suffered from a time-lag that prevented accurate prediction of Japanese aircraft attacks. The USN response was to increase the size and capabilities of the CICs (by increasing the number of raids plotted at one time as well as the channels used for aircraft direction), but most importantly by decentralising the use of CICs. A number of destroyer and destroyer escorts were fitted with radar control and communications systems to form CICs in what became known as 'radar picket ships'. USN aircraft could be allocated to these picket ships and operate individually or in small numbers over a much wider area. At the war's end airborne CICs, consisting of AEW/radar/direction installations on suitable aircraft, were being trialled.

### **Internal Communications**

Internal communications occur within a ship, submarine or aircraft. For a ship internal comms included voice pipes & speaking tubes, mechanical relays and transmission lines (engine telegraph connecting bridge to stern using chains & linkages & with associated bells and pointers), loudspeaker systems (Now hear this!), internal phones (hand phones with switchboards, using No 1 Main Circuit), and sound-powered phones (from 1942). For these Rules all forms of internal communications are considered 100% effective without delays, except when they are damaged through enemy action.

## **Naval Intelligence**

Intelligence underpins most tactical combat undertaken at sea, hence all navies maintained dedicated organisations for the collection, analysis and dissemination of naval intelligence. This not only included information on enemy ships, aircraft, weapons, bases, organisations and plans, but also included information on: enemy, allied and neutral shipping; international and coastal trade; the movement of essential raw materials, processed goods and products, as well as rare and essential items; and other aspects of economic warfare. Overall the naval intelligence organisations maintained a watching brief on all activities that involved the use of the sea - a truly maritime watching brief.

Each naval campaign simulated by these rules will necessarily include intelligence briefs for each side, which will include all relevant information available. As the NAVSIM rules are intended to represent real life decision making and subsequent actions, the intelligence briefs may also be supported by background information obtained by reference to source material. For example reading about U-boat operations during 1943 could provide additional guidance for someone acting as an Allied anti-submarine force commander in a related NAVSIM Atlantic campaign.

Signals intelligence and cryptanalysis have already been mentioned. Such activities generally disseminate information at the strategic or operational level, and hence would normally be included in the campaign briefs. Tactical use of naval intelligence is most useful when a commander makes decisions during an action, based upon the known enemy ship, aircraft and submarine capabilities. For instance the selected engagement range for naval tactical gunfire would normally reflect the known capabilities of one's own and the enemy warship main armaments. This is where general knowledge of the accompanying volume of NAVSIM data is useful.

## SHIP ENDURANCE, REFUELLING & REPAIRS

### Fuel Consumption & Refuelling

Ship operations were generally limited by their fuel consumption, their fuel storage capacity, and the performance of their hull, propulsion systems and auxiliaries. Actual fuel consumption varies with the ship's speed - with consumption at maximum combat speed being up to 15 times that at cruising speed.

As a general guide the following table may be used for naval campaigns. Once in the operational area combat operations frequently involved ships moving at their maximum speeds for long periods of time - for many WWII TFs with many hours at 30 knots continuously. Cruising speeds (average 15kn) were used to transit to and from the operational area, using the best fuel economy. Convoys and some smaller vessels used slower speeds to reduce overall fuel consumption and to maintain the maximum speed available to the slowest ship in the convoy.

#### Warship Fuel Endurance in Days with bursts at Combat Speeds (typically 28-32kn)

Type of Vessel	RN/USN	German/Italian	Japanese
BB	8 days	7 days	8 days
Old BB (@20kn)	10 days	8 days	10 days
CV	10 days	8 days	10 days
CA	10 days	6 days	10 days
CL	7 days	5 days	8 days
DD	4 days	3 days	4 days

#### Ship Fuel Endurance in Days at Cruising Speeds (typically 14-16kn)

Type of Vessel	RN/USN	German/Italian	Japanese
BB	20 days	16 days	20 days
CV	16 days	(12 days)	16 days
CA	15 days	10 days	15 days
CL	15 days	10 days	16 days
DD	13 days	8 days	14 days
DE	13 days	6 days	10 days
Escorts	13 days	6 days	10 days
Auxiliaries	16 days	16 days	16 days

Warship cruising speed endurance is doubled if continuous speed is reduced to 7-8kn.

#### Merchant Ship Fuel Endurance in Days at Various Speeds

Type of Vessel	Speed	Endurance
Fast Merchant	8-12kn	24 days
Slow Merchant	6-8kn	24 days
Independent Vessels	Over 12kn	20 days
Ocean Liners	Over 16kn	20 days

Refuelling of fuel oil, diesel fuel and aviation fuel occurs either in a suitable naval base or alongside a suitably equipped auxiliary fleet oiler (AO). Auxiliary oilers are equipped with refuelling systems with astern and/or alongside refuelling hoses capable of refuelling vessels at cruising speed. Refuelling of all the ships in a Task Force takes 6 hours, either when the ship's are safely in the naval base or alongside

a fleet oiler. Using two fleet oilers does not affect the time to refuel. Other resupply activities may also occur during this 6 hour period - refuelling, provisioning and reammunitioning. Repair and/or maintenance activities cannot take place during these first 6 hours at base. Replenishment at sea may also take place during this 6 hour period alongside. Whenever a fleet oiler or base comes under attack by sea or air, all refuelling activities stop for at least one hour.

Typically warships maintained a reserve of 5% fuel oil in their bunkers. This would enable the vessel to attempt to return to base at a slow speed (4kn or less) if necessary. When destroyers and cruisers, operating with a fleet, required urgent refuelling to continue in an operation, it was possible to conduct an emergency refuelling from battleships and/or aircraft carriers in the same TF. For every hour of emergency refuelling the each receiving destroyer or cruiser gains 20% of its fuel bunkerage. This can only occur once on operations, until the BB or CV is itself refuelled.

Italian and Japanese naval operations were frequently circumscribed by their limited availability to fuel oil. Such limitations will need to be reflected in the specific campaign and/or operation rules.

### **Ammunition Supplies**

Each ship's ammunition supply during WWII was limited. For gunfire each 3 minute turn involved firing approximately 4 to 6 large calibre rounds per gun, 8 to 12 medium calibre rounds per gun, and 12 to 30 small calibre rounds per gun. Over time this adds up to a lot of rounds, with men moving each round, mechanically as fast as possible, between the magazines deep within the ship's hull and the breach of each gun firing on the upper decks. For these Rules each ship is capable of firing continuously for 1 hour before it runs out of ammunition. This effectively means that each gun may fire up to 20 x 3min turns. A record of the number of turns firing is to be kept for each ship's calibre and position of guns fired during the Naval Gunfire turn. Note in some instances where forward or rear firing occurs only the actual guns firing expend their ammunition supplies. Whenever the rear or fwd guns have available ammunition supplies they cannot be transferred to guns without ammunition supplies in alternative positions.

Surface ship's are only able to carry two torpedoes for each TT onboard (whether surface fired or submerged). Effectively this means they can fire once then reload and fire again before they have to replenish their onboard torpedo supplies. For submarines the number of torpedoes carried onboard is usually noted in the submarine characteristics. Submarine reloads are possible up to the limit of the torpedoes carried onboard.

Resupply of ammunition and torpedoes occurs either in a suitable naval base or by a designated auxiliary vessel. Such vessels may include depot ships, ammunition ships, replenishment vessels and the like. These vessels must be designated as suitable for each class of vessel being resupplied. It is no use giving 5-inch shells for a destroyer to a battleship needing 16-inch ammunition. Ammunition resupply is conducted during the first 6 hours whenever the ship's are safely in the naval base or alongside their support vessels. All resupply activities occur during this first 6 hours - refuelling, provisioning and reammunitioning. Repair and/or maintenance activities cannot occur during these first 6 hours at base. Replenishment at sea also takes place during this 6 hour period alongside. Whenever a base comes under attack by sea or air, all resupply activities stop for at least one hour.

### **Submarine Resupply**

In the Mediterranean British and Italian submarines frequently conducted relatively short patrols, typical maximums were 30 day patrols. In the Atlantic German U-boats typically operated for up to 130 days without resupply. Much of this time was spent at very low speeds or motionless, lying in wait for an enemy target to arrive. Their patrols often ended when they had run out of torpedoes. Resupply submarines did extend the endurance of both German and Italian submarines in their operational areas. In the Pacific US submarines typically had a 75 days endurance. Actual ranges at cruising speed, on the surface and for various submerged speeds vary from class to class - refer to the Ship Characteristics (and other relevant sources).

### **Aircraft Resupply**

Aircraft operations were limited by their fuel endurance and associated cruising speeds. These are reflected in the air combat rules. Aircraft are refuelled and rearmed at their base and/or aircraft carrier using the relevant *Flat Top* rules. Each aircraft is limited by the amount of munitions they can carry and the amount of air-to-air ammunition they can carry. The air-to-air ammunition is limited to three turns of firing. Bombs, torpedoes and other airborne weapons are limited by the number carried onboard and the attacks undertaken. Resupply of aircraft can only occur at their base - airfield, seaplane base, aircraft auxiliary, or aircraft carrier. Each of these types of aircraft bases have their own limitation regarding replenishment and resupply. Generally such limitations do not form part of these rules as sufficient aircraft supplies for use during most operations and short campaigns were available. If special arrangements are necessary, such as the need for an aircraft replenishment carrier like HMS *Unicorn* in 1945, then the campaign scenario will by necessity deal with it.

## Warship Maintenance and Repair

The condition of all warships deteriorates over time, and whereas on a merchant vessel if some systems did not operate to their design limits they could often be ignored, warships needed to be fully effective to engage in naval combat. The need for warship maintenance is covered by the following naval campaign rules.

Ship Maintenance Tasks (SMT) accrue for every hour that a vessel is operational (whether in transit or in a combat zone) in accordance with the following table.

Type of Vessel	SMT accrued		Operational Hours
BB & CV	1 hour	for every	12 hours
CA	1 hour	for every	8 hours
CL	1 hour	for every	4 hours
DD & smaller	1 hour	for every	3 hours

The SMT hours accrue for each vessel until they reach a maximum of 720 hours (30 days) at which time the ship must return to the nearest naval base capable of undertaking ship maintenance but having reached this maximum all SMT hours are doubled. It is preferable to conduct frequent SMT to reduce these hours before the 720 hour limit is reached. This involves conducting ship maintenance at an appropriate base for a set number of hours in dock or alongside naval dockyards or workshops. Three hours of SMT action will reduce the accrued hours accordingly. Not maintenance cannot occur during the same hour as an air or ship raid, nor can replenishment activities occur at the same time as SMT.

Ship repair is the other side of the naval workshop effort. Critical battle damage repair is also conducted at appropriate naval dockyards and workshops. Ship Repair Tasks (SRT) have associated times to complete, and these are by necessity added to the SMT hours to return a warship to standard.

The campaign will need to define what SMT and SRT are capable at each naval base. At times the warship will have to return to its home base or a builder's yard to obtain a suitable repair. Alternatively, the warship may opt to continue operations have had the capability made safe by removing it completely. For example the British battleship HMS *Warspite* was hit by a German radio-controlled glider bomb which caused massive damage. One of her boiler rooms and the X gun-turret (15-inch) were beyond repair. It was decided that *Warspite* would be needed at the Normandy landings so it did so with less speed and six instead of eight main guns.

Dockyards and floating docks were also necessary to clean the ship's hull from marine growth and to check its underwater fittings. A 'docking' had to be done at least every year to avoid reducing the warship's maximum speed - say loose 2kn speed if hull is not cleaned. Also the dock itself had to be large enough to take the

larger sized vessels - BB, CV & large commercial vessels. When accruing SMT hours ensure that at least 16 hours of 'docking' is conducted once a year.

### **Towing Ships**

Disabled or crippled ships may be towed by other ships at up to 15kn (moving 15nm each hour move). Both ships must be alongside at the start of the turn they commence towed movement. Towed ships can be cut away at anytime during a movement turn. PGs & SMs cannot tow other vessels but may be towed themselves.

Towing speed (in knots) is 15kn if the towing vessel(s) has double or more the points of the towed vessel.

Towing speed (in knots) is 10kn if the towing vessel(s) has equal to double the points of the towed vessel.

Towing speed (in knots) is 5kn if the towing vessel(s) has half to equal the points of the towed vessel.

If the towing vessel has less than 1/2 the points it cannot tow unless it is a tug.

A tug can always tow at a minimum of 5kn.

### **Rescuing Survivors**

When a larger warship or transport is sunk (not DD or smaller), other rescue vessels (not PG, SM or smaller) may elect to rescue survivors. This involves a rescue vessel remaining stationary alongside the survivors to be rescued for 1 hour (one campaign turn). Survivors may be rescued from the water for 5 hours after which they are too dispersed. Each large warship or transport sunk will have 5 Survivor Factors, while each rescue vessel can accommodate up to 2 Survivor Factors.

## APPENDIX: CRITICAL HIT CHARTS & TABLES

The following charts and tables are to be used for WWII naval simulations iaw the NAVSIM 1939-45 rules. The following pages contain: Critical Damage Tables (CDTs), and the list of Critical Damage Effects (CDEs).

### Critical Damage Tables (CDTs) - Gunfire

Target Warships STF 25/16 or greater – BB,CA,CL

	0	1	2	3	4	5	6	7	8	9
0	89	31	10	70	02	78	05	33	54	53
1	32	63	27	04	53	43	05	24	29	01
2	51	212	37	04	15	55	19	17	79	07
3	64	32	51	16	17	29	34	74	44	33
4	71	45	44	10	35	72	62	11	08	65
5	25	26	56	24	36	42	73	40	66	42
6	58	03	68	57	23	14	41	51	34	04
7	17	26	09	69	26	06	67	24	23	89
8	59	60	13	29	78	25	18	19	28	80
9	12	17	53	61	90	50	38	39	19	01

Target Warships STF 24/15 or less – CL,DD,DE,PG etc.

	0	1	2	3	4	5	6	7	8	9
0	01	40	51	02	66	05	89	79	27	11
1	89	51	65	09	90	37	01	64	89	17
2	07	64	22	67	43	56	12	42	53	04
3	54	21	24	22	68	19	27	70	04	12
4	36	55	37	01	78	39	51	04	23	35
5	44	43	79	19	90	40	53	24	33	29
6	02	56	66	89	90	41	62	63	34	70
7	18	26	26	57	06	05	32	59	10	51
8	21	69	78	03	74	17	23	41	17	80
9	37	60	42	28	68	29	50	61	24	26

Target Aircraft Carriers – CV, CVL, CVE, AVs

	0	1	2	3	4	5	6	7	8	9
0	01	45	18	66	73	35	31	04	43	65
1	51	19	57	02	72	94	05	21	27	17
2	21	28	58	95	53	89	51	24	93	42
3	29	50	47	41	24	03	59	06	55	54
4	90	30	40	12	62	26	38	56	79	46
5	91	45	18	66	73	35	31	04	43	65
6	51	19	57	92	72	94	05	21	27	17
7	21	28	58	95	53	89	51	24	93	42
8	29	50	47	41	24	03	59	06	55	54
9	90	30	40	12	62	26	38	56	79	46

Target Merchant Vessels, Auxiliaries & Trawlers, etc.

	0	1	2	3	4	5	6	7	8	9
0	01	40	66	29	38	18	49	28	48	89
1	05	99	98	02	59	45	76	41	90	17
2	54	65	78	30	62	53	96	03	29	55
3	77	43	27	72	26	68	42	71	56	97
4	17	50	30	21	32	51	12	58	24	45
5	01	40	66	29	38	18	49	28	48	89
6	05	99	98	02	59	45	76	41	90	17
7	54	65	78	30	62	53	96	03	29	55
8	77	43	27	72	26	68	42	71	56	97
9	17	50	30	21	32	51	12	58	24	45

Critical Damage Tables (CDTs) – Bombing & Torpedoes

Aerial Bombing vs Ships

	0	1	2	3	4	5	6	7	8	9
0	11	49	24	45	01	53	55	88	36	35
1	49	25	52	51	50	40	39	38	33	34
2	24	56	26	29	56	25	26	29	34	35
3	45	41	31	38	42	52	55	11	01	88
4	53	42	30	41	51	56	49	32	33	36
5	01	43	39	45	50	25	26	48	38	39
6	54	44	27	24	27	30	43	30	40	41
7	55	46	27	53	28	31	44	29	47	46
8	88	47	40	54	56	52	51	57	57	54
9	25	48	28	28	46	47	48	50	32	05

DCs, Bombs & Guns vs Submarines

	0	1	2	3	4	5	6	7	8	9
0	81	78	20	68	51	53	84	24	83	81
1	40	56	65	52	54	75	67	88	21	89
2	66	52	82	55	17	26	85	79	62	64
3	41	83	90	72	05	86	57	43	28	20
4	81	39	35	12	01	87	03	04	02	81
5	81	78	20	68	51	53	84	24	42	81
6	40	56	65	52	54	75	67	88	21	89
7	66	52	82	55	17	78	85	79	62	64
8	41	83	90	72	05	86	57	55	55	20
9	81	51	72	12	01	87	03	04	02	81

Torpedoes & Mines vs Ship Torpedo Ratings (TRs)  
(SK = sunk, D10 x turns [3mins] equals time to sink)

	A	B	C	D	E	F	G	H
0	SK	SK	SK	103	103	103	103	103
1	SK	SK	102	102	102	102	102	102
2	SK	SK	103	101	106	105	105	104
3	SK	102	101	100	105	104	107	107
4	SK	103	100	106	104	107	107	107
5	102	101	106	105	107	107	108	108
6	103	100	105	107	107	108	109	109
7	101	107	107	107	108	109	109	109
8	100	107	107	108	109	109	109	109
9	110	110	110	110	110	110	110	110

## Critical Damage Effects (CDEs)

CDE	Description
01	Dud. Shell lodges in superstructure no damage.
02	Bridge hit, causes confusion. No firing & course changes next turn. ID.
03	Captain killed. No firing, same course for 2 turns. Minor fire on bridge.
04	Minor fire in the superstructure.
05	Major fire in the superstructure.
06	Serious fire in the superstructure.
07	Fire control centre hit. A5. Can only fight one fire each turn.
08	Gunnery radar room destroyed. No fire bonus. If no radar ED only.
09	Gunnery control hit. Minor fire. Smoke prevents firing of all guns while fire continues.
10	Gunnery control hit. Minor fire. Smoke prevents firing of fwd guns while fire continues.
11	Gunnery control hit. Minor fire. Smoke prevents firing of aft guns while fire continues.
12	Radio mast hit. No communications. Needs repairs in harbour.
13	Serious fire on boat deck.
14	Serious fire of aircraft on catapult. Aircraft destroyed.
15	Gunnery control destroyed. A5. Main guns cannot fire.
16	Secondary gunnery control destroyed. A5. Secondary guns cannot fire.
17	Near miss. ED only.
18	Conning tower hit. A5. Double damage. Loss of control. No changes 2 turns.
19	Conning tower hit. A5. Loss of control. Full turn port/stbd (50%) for 2 turns.
20	Conning tower hit and lookouts killed. Submarine unable to submerge.
21	Explosion on deck. Double ED.
22	Depth charge racks hit. Destroyed. Roll of 6 means DCs explode. Loss of ship (<STF20)
23	Searchlights hit. No night firing. ED.
24	Secondary guns hit. A4. One gun destroyed.
25	Secondary guns hit. A4. Two guns or turret destroyed.
26	Anti-aircraft guns hit. Minor fire. 3 medium or 6 small AA guns lost. -6 AAF.
27	Anti-aircraft guns hit. Major fire. 6 x medium or 12 small AA guns lost. -12 AAF.
28	AA gun control hit. No anti-aircraft fire for 2 turns.
29	Minor fire below decks. A2. (1 aircraft lost per turn).
30	Major fire below decks. A2. (3 aircraft lost per turn).
31	Serious fire in fuel bunkers. A2. Double damage. Loose 1 hour endurance per turn oil burns.
32	Hit on main turret. A3. Forward 'A' turret knocked out.
33	Hit on main turret. A3. Aft turret knocked out.
34	Hit on main turret. A3. Fwd midships 'B' turret knocked out.
35	Secondary ammo explosion. A4. Double damage. No fire one turn.
36	Hit is shell handling room. A1. Fails to explode. No main guns fire for 2 moves.
37	Hit in torpedo tubes. 50% chance of explosion (damage from each torpedo in tubes).
38	Secondary gun ammo hoist damaged. Secondary gunfire reduced to every 2 turns.

39 Flash-fire in main turret. A3. Permanently out of action (roll for which turret).

40 Steering flat wrecked. A2. Ship circles port for 3 turns.

41 Steering flat wrecked. A2. Ship circles stbd for 3 turns.

42 Magazine hit. A3. Threatened by flash-fire. Ship saved.

43 Magazine hit. A3. Flash spreads and ship explodes. Ship sinks in D6 turns.

44 Shell hits main turret. Jammed in position (roll for which turret).

45 Serious fire below decks. A2. (6 aircraft destroyed per turn).

46 Aircraft list hit. Jammed in position. (roll for which lift if more than one).

47 Hole in deck. A2. Minor fire. Aircraft cannot take-off or land for 1 hour.

48 Hit passes through deck. A2. 10% of supplies destroyed.

49 Hit passes through deck. A2. Major fire. 25% of supplies destroyed. AO explodes.

50 Hit passes through funnel to explode in boiler room. Serious fire. Loose 5 kn.

51 External detonation (ED) on deck/casing.

52 Damage to torpedo tubes, Unable to fire (roll for which ones - fwd/rear).

53 Hit waterline. A1. Ordinary damage.

54 Hit waterline. A1. Double damage.

55 Hit waterline. A1. Engines and shafting damaged. Loose 5 kn.

56 Hit waterline. A1. Minor flooding (100 pts/turn).

57 Hit waterline. A1. Double damage. Major flooding (250 pts/turn).

58 Hit waterline. A1. Double damage. Serious flooding (600 pts/turn).

59 Hit in engine room. A1 Steam pipe fractured. Serious fire. Ship stops for 2 moves (4.5.6 fixed).

60 Hit in generator room. A1. Power failure to all guns for 2 turns. (Repaired on 4.5.6).

61 Hit fuel tanks. A1. 10% of oil fuel contaminated. Loose 10% of endurance.

62 Hit fuel tanks. A1. 2% of fuel lost per day. Trailing oil. Loose 2 kn.

63 Hit to power distribution system. A1. All guns cease fire (roll 5, 6 to rectify)

64 Propeller shaft damage. Speed drops by  $\frac{1}{4}$ .

65 Hit in engine room. A1. Major flooding. Permanent speed  $\times \frac{1}{2}$ . (Harbour repairs)

66 Hull/casing torn apart at waterline. A1. Double points. Minor flooding. Loose 2 kn.

67 Boiler room/switchboard explosion. A1. Major fire. Ship stops dead in water, immobilised.

68 Rudder jammed in current position. (roll of 6 (D6) per turn to fix).

69 Main magazines flooded. A1. Two moves firing left for main guns.

70 Secondary magazines flooded. A1. Two moves firing left for secondary guns.

71 AA magazines flooded. A1. Two moves firing left for AA guns.

72 Hole at waterline. A1. Serious flooding. Double pts each turn counter-flood. (Roll a 6 to fix).

73 Hangar hit. Flooding aircraft ammunition store destroyed.

74 Auxiliary machine space hit. Freshwater spoiled. Water purifier destroyed. Must head to harbour.

75 Submarine receives catastrophic hit amidsthips breaks up and sinks. Oil and refuse visible.

76 Flooding damages 10% of cargo/supplies.

77 Flooding damages 25% of cargo/supplies. Trailing oil in water.

78 Shell/bomb/depth charge/mine near miss.  $\frac{1}{2}$  ED.

79	Shell/bomb near miss. ½ ED.
80	Structural damage below decks. Flood control party trapped and killed.
81	Submarine near miss. ½ damage points.
82	Submarine destroyed. If submerged no evidence of damage or loss.
83	Submarine hit and critical leak caused. Unable to dive. Must surface within 5 turns.
84	Submarine destroyed. Oil slick and flotsam rises to surface.
85	Submarine hit and loses battery power. Stops dead. Can surface by blowing air.
86	Submarine hit and loses power. Stops dead. If submerged cannot surface.
87	Submarine hit near torpedo tubes. Inoperable. If open for firing they explode on 5,6 roll.
88	Submarine seawater system damaged must surface immediately. (2 hours to fix).
89	External detonation (ED). AA gun(s) hit. AAFF reduced by 10 pts.
90	Underwater explosion. Near miss. Propeller bent. Speed reduced by 1 kn (surface & submerged).
91	Dud shell/bomb lands on deck. Thrown overboard by killick.
92	Air offices hit, causes confusion. No air orders for one hour. ID.
93	Hangar fire. A2. Serious fire spreads across hangar. Uncontrollable 4 turns. 6 a/c lost per turn.
94	Stern tube near miss. Minor flooding. Shaft bent. Speed reduced by 2 kn.
95	Aviation fuel tanks hit. A3. Major fire. No aircraft readying/refuelling for 1 hour.
96	Flooding damages 10% of cargo/supplies. Crew abandons ship (unless warship).
97	Flooding damages 25% of cargo/supplies. Crew abandons ship (unless warship).
98	Hit passes through deck. A2. Single ID points. Minor fire. Crew form temp DCP.
99	Hit passes through deck. A2. Double ID points. Major fire. Crew form temp DCP.
100	Major hit. Forward. Serious Flooding. TT points damage. Reduce speed by 5 kn.
101	Major hit. Aft. Serious Flooding in Engine/Boiler room. TT points damage. Now ½ speed.
102	Major hit. Double damage. Major flooding. Reduce speed by 2 kn.
103	Serious hit. Double damage. Engine/Boiler room destroyed. Ship dead in water.
104	Minor hit. Damage points +300. Minor flooding.
105	Minor hit. Damage points. Reduce speed by 2 knots.
106	Major hit. Damage pts + 1400pts. Uncontrolled major flooding for 2 turns, then major flood.
107	Hole in side of ship. Normal damage only.
108	Explosion absorbed in A1. One half damage points (if no A1 normal damage points).
109	Explosion absorbed in A1. No damage (if A1 present) otherwise normal damage only.
110	Torpedo fails to explode. No damage.

#### **Fires and Flooding Damage:**

Fire and flooding damage are categorised as Minor, Major or Serious. Minor fires/flooding cause 100 pts damage when started and for each subsequent turn not brought under control. Major fires/flooding cause 250 pts when started and each subsequent turn. Serious fires/flooding cause 600 pts when started and each subsequent turn.

Heavy naval guns have no limitations wrt the Critical Damage Effects. Medium naval guns (6 to 10-inch) cannot cause serious fires/flooding on battleships (BB) – all such effects are reduced to major fires/flooding. Small naval guns (<5.6-inch) cannot cause serious or major fires/flooding on BB, CA or CL – all such effects are reduced to minor fires/flooding. Torpedo and aerial bombing hits have no such limitations.

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